1973

Limnology of the University Lake System, Baton Rouge, Louisiana.

Mary-grace Curry
Louisiana State University and Agricultural & Mechanical College

74-18,331

CURRY, Mary-Grace, 1947-
LIMNOLOGY OF THE UNIVERSITY LAKE SYSTEM,
BATON ROUGE, LOUISIANA.

The Louisiana State University and Agricultural
and Mechanical College, Ph.D., 1973
Limnology

University Microfilms, A XEROX Company, Ann Arbor, Michigan

Limnology of the University Lake System,
Baton Rouge, Louisiana

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Botany

by
Mary-Grace Curry
B.S. Louisiana State University in New Orleans, 1969
M.S. Louisiana State University in New Orleans, 1971
December, 1973

Acknowledgments

The author acknowledges her committee Drs. Charles A. Schexnayder, William J. Luke, Walter J. Harman, J. Michael Fitzsimons and Shirley C. Tucker. Also acknowledged are Dr. Ray Ferrell, Jr. (LSU - Geology), Miss Jane Christian and Mr. Robert Kuss (Louisiana Wild Life and Fisheries Commission, Division of Water Pollution Control) and Mr. Billy R. Bordelon and Dr. Michael A. Poirrier (LSUNO - Biological Sciences) for the use of equipment and/or facilities.

Finally the author extends sincerest appreciation to Miss Betty Everitt and Mr. Guy J. Denoux for their inestimable contributions, to Dr. Walter G. Moore (Loyola University - Biology) for reading and discussing this dissertation, to Dr. Dempsey L. Thomas (LSUNO - Biological Sciences) for his phycological advice and to Mrs. Marie LeBlanc (LSUNO - Biological Sciences) for typing this dissertation.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

Page

Abstract

This is a limnological survey of six 45-year-old, fresh-water impoundments on or near the Louisiana State University campus in Baton Rouge, Louisiana. The objectives were to identify the contained organisms, to compare their occurrence and distribution, to determine the physicochemical parameters, to determine the efficiency of the lakes and to establish general reconnaissance data for the area. Physicochemical data obtained monthly from seven shoreline stations over twelve months included: temperature, pH, dissolved oxygen, free carbon dioxide, alkalinity, hardness, specific conductance, phosphate, ammonia nitrogen, nitrate nitrogen, hydrogen sulfide, apparent color, turbidity, transmittance, transparency, iron and relative stability. Quarterly diel studies of temperature, dissolved oxygen, free carbon dioxide and alkalinity included determinations every two hours over a 24-hour period. Primary productivity estimated with the diel studies and with light and dark bottles indicated high productivity, and bottom sediment analyses revealed soils rich in extractable nutrients. The lakes were alkaline, stable, eutrophic ecosystems which may present borderline physicochemical conditions for many organisms therein. Random biological sampling for eighteen months revealed 35 species of

algae, 37 species of tracheophytes, 76 species of invertebrates and 16 species of fishes. Two leeches, *Helobdella fusca* and *H. stagnalis* were reported new to Louisiana. Tentative state records included the leech *Dina parva*, the ectoproct *Hyalinella punctata* and the odonate nymph *Brechmorrhoga mendax*.

Introduction

The limnological investigations in the South, particularly in Louisiana and surrounding states, have been few. Shannon and Brezonik (1972) state that although Florida has more than 7,500 lakes, limnological investigations have been few and limited and that, as a group, Florida lakes are almost limnologically unknown. Moore (1963), in a discussion of major areas of limnological activity, reports that limnological investigations in the Central Gulf States area (Louisiana, Mississippi, Alabama and Arkansas) have been few and have been mostly of a general reconnaissance character. Young, Hannan and Tatum (1972) also report that few physicochemical studies of a comprehensive nature have been undertaken on fresh-water ecosystems in Texas.

Published information on the general limnology of Louisiana lakes is "meager and the need for further research is increasingly evident" (Fuss, 1959). Limnological studies in Louisiana include those of Moore (1950, 1952 and 1970) on Lake Providence, Lake Chicot and temporary ponds in southeastern Louisiana; Sublette and Sublette (1957) on Chaplin's Lake; Buckley (1958) on the Upper Cane River Lake; Fuss (1959) on the limnological reconnaissance of three Louisiana lakes; Smith (1959) on selected water bodies in the western part of Cameron Parish; Geagan and Allen (1960) on Caddo Lake, Cane River

Lake, Lake Chicot and Lake Providence; Stern, Atwell, Merz and Vinet (1968) and Stern and Stern (1969) on Lake Pontchartrain (an estuary); Pesnell (1971) on the Toledo Bend Reservoir; and Cali (1972) on a brackish-water pond system in New Orleans. Investigations on ecology and distribution of fresh-water biota, however, are more numerous and include the fauna and flora of Cypress Lake (Liner, 1949), algae (Prescott, 1942), vascular plants (Curry and Allen, 1973), sponges (Poirrier, 1969), bryozoans (Everitt, 1972), odonates (Bick, 1957), cladocerans (Jones, 1958), and fishes (Lambou, 1959), to name only a few. A comprehensive treatment of the accomplishments in Louisiana fresh-water biology through 1963 is presented by Moore (1963) in a treatment on the Central Gulf States and the Mississippi embayment.

This work is the first limnological study of the University Lake System. The system (Fig. 1), consisting of six picturesque lakes, is located in the city of Baton Rouge, East Baton Rouge Parish, Louisiana. It is surrounded by City Park, Louisiana State University and one of the city's finest residential areas. The lakes provide year-round recreation, such as boating, fishing and day dreaming, to inhabitants of the capitol city. The lakes also provide students and faculty with specimens and opportunities for laboratory and field investigations of all kinds.

The objectives of this study were as follows: to identify the contained animals and plants, to compare their occurrence and distribution, to determine physicochemical parameters of the lakes, to determine the efficiency of the lakes as self-maintaining ecosystems, to establish general reconnaissance data for future studies, and to augment the literature for comparative studies. Perhaps this study of the University Lake System will encourage research in areas such as primary productivity, taxonomy, ecology and distribution of fresh-water organisms; the possible control or prevention of the almost annual fish kills on these lakes; any other limnological studies, particularly reconnaissance investigations of fresh-water habitats in the South.

History of the University Lake System

According to Cox (1940), the general geologic history of the area of the University Lake System can be traced to the Pleistocene, at which time the Mississippi River had developed a floodplain approximately 25 to 30 feet above the present floodplain. Following this development, the river rejuvenated, cut at least 200 feet lower than the present level, and left the floodplain as a terrace, which is now referred to as the Prairie Terrace.

The lakes of the University Lake System are all manmade. The first lakes constructed were City Park Lake and Lake Erie, when Bayou Duplantier, a tributary to the Mississippi River, was dammed in 1925 by the city of Baton Rouge, after the acquisition of some fifty acres from the Gaz-Parkins Realty Company for the purpose of constructing a lake and recreational area.* This area was a natural levee which, when the flow of Bayou Duplantier was reversed, produced lowlands in the backswamp of the Mississippi River floodplain, then known as "old Perkins swamp."

Several years later, during the summer of 1933, some one thousand men were hired by the Baton Rouge Chamber of Commerce to clear the

---

* Conveyance Records, May 30, 1925, Parish of East Baton Rouge, 54/519.

Conveyance Records, March 11, 1931, Parish of East Baton Rouge, Book No. 249, Sheet 91, 6/802.

areas now known as University Lake, Lake Crest and College Lake. This action was continued for the next five years by the New Deal's Works Progress Administration. Mules and draglines were used to remove one million feet of timber, at a cost of $335,800 to the Federal Government (Fisher, 1972).

After the lakes were built, water was provided by a 10-inch, 2,600-foot artesian well near the LSU stock barns and by rainfall and surface runoff. According to Cox (1940), two ice plants were wasting water into storm sewers emptying into City Park Lake, and an artesian well was diverted into one of the storm sewers for 23 hours each day. In addition, in City Park there was a municipal swimming pool, the wastes of which flowed into City Park Lake.

Lake Erie, City Park Lake, University Lake and Lake Crest were interconnected by concrete flumes that provided free passage of water and organisms. A spillway was constructed under Stanford Avenue to maintain the water level. Louisiana Wild Life and Fisheries Commission later stocked the lakes several times with largemouth bass, sacalait, bluegill and perch. The original depth of the lakes was 4 to 15 feet. City Park and University lakes have been dredged several times, beginning in 1951 with a small channel around the periphery of the lakes to remove problem vegetation. These lakes were deepened in 1967 by the installation of stoplogs in the spillway culverts, and again in 1968 by blocking a box culvert connecting these two lakes, with sheets of plywood, creating a dam-like effect, increasing lake depth 12 inches each time.

The Lakes Today

University Lake, sometimes called LSU Lake, is the largest lake of the University Lake System and covers 188.1 acres* (McElveen, Assistant Comptroller, LSU, personal communication). Its maximum depth is approximately 6 feet. The silt deposited in its basin is less than 1.5 feet thick. There is little or no littoral area, and most of its periphery is occupied by a dense growth of elephant-ears (*Colocasia antiquorum*), an important source of organic material. University Lake connects with City Park Lake to the north and with Lake Crest to the west. It overflows a spillway into Bayou Duplantier at its southeastern corner. University Lake is a part of the Louisiana State University campus and is under the auspices of the LSU Board of Supervisors.

Second in size is City Park Lake. It is the oldest of the six lakes and occupies 48.0 acres (McElveen, Assistant Comptroller, LSU, personal communication). Eighty-seven per cent of this lake is less than 3.5 feet deep, the maximum depth being 4.5 feet (Odom, 1968). Silt deposited in the lake's bottom is less than 1.5 feet thick. There is little or no littoral area, and most of its periphery is also occupied by a dense growth of elephant-ears. A section of interstate

---

* The Times Picayune (1961) gave lake areas as follows: University Lake, 218 acres; City Park Lake, 61 acres; College Lake, 9.4 acres.

10, constructed in the late fifties, now passes over the north end of City Park Lake. Also at its north end is the system's principal inlet, Bayou Duplantier, which flows from the north through City Park's golf course before entering the lake. City Park Lake connects to the east with Lake Erie and a private pond and to the south with the larger University Lake. City Park Lake is not located on the LSU campus and is under the direction of the Baton Rouge Recreational Committee (BREC).

Campus Lake, commonly known as Coliseum Pond, and sometimes incorrectly referred to as College Lake, occupies 8.3 acres (McElveen, Assistant Comptroller, LSU, personal communication). This lake is approximately 3.0 feet deep and has silt deposits greater than 1.5 feet thick. Campus Lake has the largest accumulation of allochthonous leaf litter in various stages of decay which upon agitation releases odorous quantities of hydrogen sulfide. The approximately rectangular outline of Campus Lake is impounded by a stone and concrete embankment. There are littoral-like areas at points along the periphery. Campus Lake is connected to no other lake in the system. It drains into the Corporation Canal near its east end and is maintained by LSU.

Equal in size to Campus Lake is Lake Crest, occupying 8.3 acres (McElveen, Assistant Comptroller, LSU, personal communication). Some of the deepest areas in the system are in this lake. Silt deposits are less than 1.5 feet thick. Lake Crest's somewhat rectangular outline is surrounded by elephant-ears to the west and east. Lake Crest connects to the east with University Lake and is privately owned.

College Lake, also known as College Park Lake, is the smallest lake on the LSU campus and occupies 3.7 acres (McElveen, Assistant Comptroller, LSU, personal communication). There are no associated elephant-ears and little or no littoral area. Portions of this lake are deeper than 6 feet with a silt deposit of more than 1.5 feet. College Lake has no interconnections to the other lakes but has an outlet to the Corporation Canal at its easternmost corner. The lake is maintained by LSU.

Lake Erie is a pear-shaped lake covering 3.0 acres. It is the smallest of the seven lakes and has a maximum depth of 6 feet. There are associated elephant-ears. Silt deposited in its basin is less than 1.5 feet thick. Lake Erie connects with City Park Lake to the west and is under the direction of BREC.

Although these lakes are usually thought of as individual lakes, their interconnections (Campus and College lakes excluded) also enable them to be studied as one "super organism." As previously mentioned, however, these interconnections were occluded in 1968, and although there is water overflow, a relatively closed environment has been created, preventing the escape of most organisms from adverse conditions which often occur in only one of the lakes at any one time. This is evidenced by the most recent fish kills confined to City Park Lake.

Materials and Methods

Surface Water and Bottom Sediment Analyses

Seven stations (Fig. 2) were selected on the basis of accessibility and relationship to one another. No two areas were adjacent and, therefore, each station reflected the individuality of its parameters over a twelve-month period. A description of each station follows.

Station 1 - Lake Crest "littoral area" on west side along July Street.

Station 2 - City Park Lake pier, approximately 20 feet from shoreline along west side at Dalrymple Drive.

Station 3 - University Lake "littoral area" on northwest side near East Lakeshore Drive.

Station 4 - University Lake at Alpha Tau Omega Fraternity pier, approximately 30 feet from shoreline near West Lakeshore Drive.

Station 5 - Campus Lake from rock and concrete embankment on south side near South Stadium Road.

Station 6 - College Lake shoreline on west side near East Parker Drive.

Station 7 - Lake Erie "littoral area" on east side along East Lakeshore Drive.

Each month a series of tests was run at each of seven stations. Air and water temperature, pH and RpH, total alkalinity (carbonate and bicarbonate), free carbon dioxide and dissolved oxygen were determined in the field. Orthophosphate, ammonia nitrogen and nitrate nitrogen, iron, copper, chloride, hydrogen sulfide, total hardness (calcium and magnesium), color, turbidity, transmittance, specific conductance and relative stability were determined in the laboratory. Unless otherwise stated, water to be tested was collected approximately one to two feet below the surface. All water was collected between 10 A.M. and 12 noon. Polyvinylchloride bottles were used in water transport. Physicochemical data is appended (Appendix A and B).

Every three months a similar series of tests was run every two hours over a 24-hour period (6 P.M. - 6 P.M.) at Station 4. These quarterly diel studies included water and air temperature, pH and RpH, total alkalinity, free carbon dioxide and dissolved oxygen.

Primary productivity determinations were made at Station 4. The light and dark bottles (Gaarder and Gran, 1927) were set out at 12 noon and collected and analyzed by the Winkler Method (Welch, 1948) at 3 P.M.

Other determinations were made by the following methods:

Air temperature - approximately 4 feet above water surface.

Water temperature - approximately 12 inches below water surface.

pH and RpH - Rascher and Betzold Colorimetric pH Kit.

Total alkalinity - methods outlined in Welch (1948).

Free carbon dioxide - methods outlined in Welch (1948).

Dissolved oxygen - Winkler Method (Welch, 1948).

Oxygen saturation values - determined with a nomogram (Rawson, 1944).

Orthophosphate - StannaVer Method (Hach Chemical Co., 1967).

Ammonia nitrogen - Nessler's Method (Hach Chemical Co., 1967).

Nitrate nitrogen - Cadmium Reduction Method (Hach Chemical Co., 1967).

Copper - Cuprethal Method (Hach Chemical Co., 1967).

Iron - 1,10 Phenanthroline Method (Hach Chemical Co., 1967).

Chloride - Mercuric Nitrate Method (American Public Health Association, 1971).

Hydrogen sulfide - Methylene Blue Method (Hach Chemical Co., 1967).

Total hardness - Hach Calcium and Total Hardness Test Kit Model HA-4P.

Color - APHA Platinum-Cobalt Method (Hach Chemical Co., 1967).

Turbidity - Formazin Method (Hach Chemical Co., 1967).

Transparency - Secchi disk.

Transmittance - Hach AC-DR Colorimeter (Hach Chemical Co., 1967).

Specific conductance - Yellow Springs Conductivity Bridge Model 31.

Relative Stability - Methylene Blue Method (American Public Health Association, 1965).

For minor metallic element analyses water samples from each station were collected in 250 ml flasks and covered with Parafilm. They were analyzed by atomic absorption spectroscopy at Kem-Tech Laboratories (Baton Rouge, Louisiana) in November for the following elements: chromium, lead, zinc, iron, copper, molybdenum and manganese.

Soil samples were collected with a core sampler from the lake basins and transported in plastic bags. Analyses included soil reaction (pH), calcium, magnesium, potassium, sodium, phosphorus, per cent organic matter and soil type. Analytical methods were those of Brupbacher, Bonner and Sedberry (1968). Soil samples were tested by the Louisiana Soils Testing Laboratory (Baton Rouge).

Biological Sampling Preservation and Identification

Plants and animals were collected randomly from the University Lake System over an eighteen month period. Checklists of all plants and animals collected are appended (Appendix C and D).

Aquatic vascular plants were collected with rakes, sticks and by hand. Vascular plants were pressed in a plant press and stored with paradichlorobenzene. All vascular plants collected were placed in the Louisiana State University Herbarium (LA) in Baton Rouge with duplicates in the University of Southwestern Louisiana Herbarium (LAF) in Lafayette.

Filamentous algae were collected with rakes, sticks and by hand. They were preserved in 4% formalin and/or mounted with Turtox CMC-10 medium. All algae collected are in my private collection.

Plankton samples were obtained with a fine mesh plankton net (65-2160, Carolina Biological Supply Co.). Phytoplankton was preserved in 4% formalin and/or mounted with Turtox CMC-10 or CMC-S media. Zooplankton was preserved in 4% formalin and/or mounted with Turtox CMC-S or CMC-10 media.

Invertebrates and fishes were collected with nets, seines, various containers, rakes and by hand. They were preserved in 10% formalin. Where special procedures were indicated in the preservation of certain groups, such as the ectoprocts, the methods used were those of Pennak

(1953). The invertebrates and fishes are in my private collection.

Protozoans were identified according to Jahn (1949) and Ward and Whipple (1959). Algae were identified according to Cocke (1967), Hutchinson (1967), Palmer (1962), Patrick and Reimer (1966), Prescott (1951 and 1964), Prescott and Vinyard (1965), Smith (1951), Ward and Whipple (1959) and Whitford and Schumacher (1969). Higher vascular plants were identified according to Brown (1972), Correll and Correll (1972), Fassett (1969), Fernald (1950) and Radford, Ahles and Bell (1968). Invertebrates were identified according to Pennak (1961), Sawyer (1972), Usinger (1971) and Ward and Whipple (1957). Fishes were identified according to Eddy (1957).

"No organism lives in its own environment without in some way having an effect upon it" and similarly, "the environment exerts considerable influence over the kinds, abundance and distribution of organisms inhabiting a given set of conditions."

Reid, 1961

Results and Discussion

Physicochemical Characteristics of the Waters

Thermal Relationships

During this study the water temperatures ranged from 1°C to 33°C, the maximum temperatures occurring in August, September and June, the minimum in January and February. The mean water temperatures were higher than the mean air temperatures. Cox (1940) observed a similar temperature relationship in City Park Lake and correlated this relationship to rate of evaporation. There were periods of 4 to 8 hours, beginning about 10 A.M., during which the air temperature was greater than the water temperature. The shortest periods occurred in the summer and fall and the longest in the winter.

Ice was never observed on the lakes during this study, although a light blanket of snow settled over the city in early January and again in early February. In the winter of 1962, however, ice did cover the lakes and was described as a "quirk of Mother Nature" (Fisher, 1972).

Unlike some other Louisiana lakes, particularly Lake Providence and Lake Chicot, both warm monomictic lakes with a winter circulation period (Moore, 1950 and 1952), the University Lake System appears to have little thermal stratification. This phenomenon (or the lack of it) is probably due to a combination of the following factors, all of which are capable of increasing wind action: broad basins, slight depth and a lack of protection by woody vegetation. In addition to these factors, the city of Baton Rouge receives an average annual rainfall of 59.29 inches (based on a 72-year record of the United States Weather Bureau), creating enough runoff to replace the water of the interconnected lakes several times annually (Odom, 1968). During April, 1973, Baton Rouge received a record rainfall of 10.1 inches. The average rainfall for the month of April is 4.4 inches. Also, because the lakes are so shallow, most rains and winds are sufficient to cause turnovers. The University Lake System is, therefore, best described as a system of third-class lakes, i.e., not thermally stratified, although "mini-thermoclines" probably exist periodically in the deeper areas, particularly in the spring, and are unnoticed. A lack of thermal stability was reported for Chaplin's Lake (Natchitoches Parish) by Sublette and Sublette (1957), who, in addition, described transitory periods of apparent thermal stratification for that lake, and by Geagan and Allen (1960) for Caddo Lake (Caddo Parish). Brief thermal stratification was detected in College Lake, Lake Erie and Lake Crest. Such temporary stratification is a common phenomenon during the spring and early summer in many shallow lakes of this area (Geagan and Fuss, 1959; Geagan and Allen, 1960). This study agreed with that of Shannon and Brezonik (1972), who studied Florida lakes lacking "classical Birgean thermoclines and stagnant hypolimnia" and suggested that "thermal stratification should be unimportant. Shallow lakes, however, are sometimes stratified. Eriksen (1966) suggested that the thermal and chemical stratification in two shallow puddles (less than 40 cm deep) in California and Montana was due to exceptionally high turbidity.

Studies over two 24-hour periods in August (Fig. 3 and 4), showed that the water temperature fluctuated only 5 degrees, while the air temperature fluctuated 11 degrees over the same period. A similar diel study in November (Fig. 5), showed water and air thermal fluctuations to be 5 degrees and 14.5 degrees, respectively, while in February (Fig. 6), thermal fluctuations were 6 degrees and 11 degrees for the water and air temperatures, respectively. In May (Fig. 7), water and air temperatures fluctuated 5 and 10 degrees, respectively. Such diel monitoring of air and water temperatures attests to the stable thermal properties of the aquatic environment.

Hydrogen Ion Concentration

The hydrogen ion concentration of natural waters is an indicator of certain environmental conditions, particularly the stability of the environment. The pH reflects the geology of the area and the photosynthetic and respiratory activity of the contained organisms.

The pH of fresh waters in Louisiana usually lies between 6.0 and 9.0 (Poirrier, 1969; Everitt, 1972). Although Louisiana has many acidic waters (my observations), only neutral to alkaline lakes have been studied limnologically.

According to Rawson (1939), changes in pH are often less than three pH units for any one system. Over this twelve-month period, no lake varied more than 2.5 pH units (Appendix A). The apparent stability of the pH was due to the abundance of dissolved buffers (carbonates and bicarbonates of calcium and magnesium). The maximum pH range for the lake system as well as stations 1, 2, 4 and 6 was 7.1 to 9.6 pH units. Lowest pH values were recorded during December at which time the water temperature range was 5.5 to 9.5°C and photosynthesis was lower than usual. All seven stations maintained a pH greater than 8.0 pH units during most of the year (Appendix A).

Maximal diel fluctuations exceeded 2 pH units and were observed in University Lake (station 4) during August following a 2-hour afternoon rain, after which the pH decreased to 7.3 at 8 A.M. and increased to 9.6 at 2 P.M. (Fig. 3). Other diel studies showed pH variations less than 0.5 pH units in the absence of rain (Fig. 4). Those studies attested to the extremely effective buffering capacity of the system. Investigations of Sechriest (1960), however, suggested that the pH of natural waters is relatively independent of total alkalinity, conductivity and buffer capacity of those waters.

Dissolved Oxygen

The concentration of dissolved oxygen probably tells more about a lake than any other single parameter (Hutchinson, 1957). Because the concentration of free carbon dioxide varies inversely with dissolved oxygen, and pH varies inversely with the free carbon dioxide, several diagnostic generalizations can be made about the nature of the aquatic habitat, both in terms of physicochemical and biological aspects. It is usually, however, impossible to separate the effects of reduced dissolved oxygen from those of increased free carbon dioxide, hydrogen sulfide or ammonia.

Most aquatic organisms can tolerate dissolved oxygen concentrations exceeding 100% saturation. Although some aquatic organisms have special adaptations and even preferences for lower dissolved oxygen concentrations, the dissolved oxygen of lake waters is a most critical factor in the maintenance of a balanced aquatic habitat.

Like many lakes and ponds in Louisiana, the University Lake System had high concentrations of dissolved oxygen because of the abundance of contained phytoplankton and the long growing season afforded by the mild climate. High dissolved oxygen has been reported by Moore (1950), Sublette and Sublette (1957), Geagan and Allen (1960) and Poirrier (1973). Moore (1950) recorded dissolved oxygen concentrations up to 18.85 ppm (245% saturation) during the summer in Lake Providence. This condition he also associated with a dense phytoplankton community. In contrast, Sublette and Sublette (1957) reported a low of 0.8 ppm dissolved oxygen from Chaplin's Lake in June. Dissolved oxygen in the University Lake System was lowest in mid-August (4.6 ppm in University Lake). These values, however, were determined during the morning of a sunny day that had been preceeded by a heavy afternoon (5 to 7 P.M.) rain, and perhaps the lakes had not fully recovered.

As would be expected, the University Lake System reaches highest dissolved oxygen concentration between 2 and 4 P.M., and lowest concentration at about 6 A.M. One 24-hour study revealed that a heavy rain lasting approximately 2 hours one afternoon was sufficient to reduce the dissolved oxygen content from greater than 100% saturation to about 18% saturation within the following eight hours. Once the sun appeared, however, the lake recovered within four hours. During the other four diel studies, the dissolved oxygen content of University Lake was always greater than 57% saturation, and most often greater than 100% saturation during the day. Such conditions of supersaturation are correlated with the usually high concentration of phytoplankton in all six lakes. Also the lakes are shallow and the lack of protection by woody vegetation allows aeration by wind action. The relationship of dissolved oxygen to fish kills is discussed in the section "Fish Kills."

Free Carbon Dioxide

Carbon dioxide is essential for photosynthesis and is, therefore, a basic component in primary productivity. Consequently, the free carbon dioxide in surface waters of lakes varies inversely with photosynthetic activity. Fortunately, carbon dioxide is seldom low enough to be a limiting factor in phytoplankton production, as phytoplankton are able to use free carbon dioxide, bicarbonates and even some monocarbonates.

For most aquatic animals the free carbon dioxide concentration must not exceed 25 ppm, after which point respiratory movements and gas exchanges are frequently impaired. During this study the free carbon dioxide concentrations varied irregularly at each station and were between 0 and 7 ppm (Fig. 8-14, Appendix A). The free carbon dioxide remained low throughout the year because of active photosynthesis by the phytoplankton.

Irregular trends in free carbon dioxide have also been reported in other Louisiana lakes. Moore (1952) found that the free carbon dioxide of Lake Chicot's surface waters was variable and ranged from 1 to 10 ppm. He also found that the surface waters of Lake Providence were generally lower in free carbon dioxide. He attributed the high free carbon dioxide in Lake Chicot to the greater amount of decaying plant material and the reduced circulation of the surface waters due to a more sheltered basin. Geagan and Allen (1960) also reported no seasonal trends in free carbon dioxide from Cane River Lake and Caddo Lake. Sublette and Sublette (1957) reported free carbon dioxide in the surface waters of Chaplin's Lake only once. In contrast, however, Poirrier (1973) reported a range of 2 to 29 ppm free carbon dioxide at one station within one month in the Audubon Park Pond System, the high and low occurring at 7.8 and 8.0 pH units, respectively.

In University Lake during two diel studies without rain (August and November), no free carbon dioxide was present. In the February diel study, the free carbon dioxide was 1 ppm at 6 A.M. and 2 ppm at 8 A.M. The greatest change in free carbon dioxide concentration occurred during one of the August studies. After a 2-hour rain during the afternoon, the free carbon dioxide concentration was 1.5 ppm at 2 A.M., 3.0 ppm at 4 A.M., 4.5 ppm at 6 A.M. (dawn), and 5.0 ppm at 8 A.M. The maximal free carbon dioxide was correlated with the minimal dissolved oxygen and pH values during that 24-hour period. The effect of the evening rain of increasing the free carbon dioxide content by reducing photosynthesis and disturbing the lake bottom is evident in the two diel studies in August (Figs. 3 and 4).

Alkalinity

Alkalinity is often used as an index of the fertility of lakes and streams. The total alkalinity is expressed as phenolphthalein alkalinity, contributed by hydroxides and carbonates, and methyl orange alkalinity, a function of the bicarbonate content of the water. In fresh waters of Louisiana, total alkalinity has been known to parallel almost exactly the trends of specific conductance (Twilley, 1970).

In this study, however, the relationship between specific conductance and total alkalinity was not as pronounced (Appendix A). The total alkalinity ranges for most stations were 12 - 69 ppm, except station 5 (48 - 304 ppm). Total alkalinity tended to be lowest during December and January. These were also months of relatively low pH due to decreased phytoplankton activity. In a similar Texas study (Respess, 1972), alkalinity also decreased in the winter. Where algae are actively photosynthesizing, carbonate alkalinity and increased pH values are common (Neel, et al., 1959).

Diel studies showed that in University Lake the phenolphthalein alkalinity was always highest between 4 and 8 P.M. Also at this time was an increase in pH and an absence of free carbon dioxide, as was expected.

The alkalinity of the University Lake System was primarily due to the bicarbonate content (to 287 ppm) of the water. Bicarbonates are also the main source of alkalinity (to 189 ppm) in other Louisiana lakes (Sublette and Sublette, 1957), while carbonates are the main source (to 198 ppm) in others (Poirrier, 1973).

The alkalinity and pH showed a close correlation pattern. This has also been found in other lake studies (Young, Hannan and Tatum, 1972).

Hardness

Calcium and magnesium are the most common ions in fresh waters. They may limit biological processes and are the principal buffers of fresh-water habitats. The concentrations of these elements, therefore, indicate the effectiveness of the buffering system of an aquatic ecosystem.

Total hardness (ppm $CaCO_3$ plus ppm $MgCO_3$), a measure of the soap-consuming power of lake waters, is a result of the geological composition of the area or industrial pollution. The relatively high total hardness of the waters of the University Lake System (51 - 171 ppm) is a function of the Mississippi River terrace soils in which the lakes were excavated. Sediment samples from the lakes contained calcium concentrations of 1520 - 4000^+ ppm and magnesium concentrations of 109 - 621 ppm. However, less than 50% of the water analyses revealed calcium hardness to be equal to or less than that of magnesium (Appendix A), indicating the decreased availability of calcium (due to precipitation of calcium salts) under more alkaline conditions.

Water hardness can be either temporary (due to carbonate salts) or permanent (due to sulphate salts (Moyle, 1945)). Temporary hardness is often considered to be practically synonymous with total alkalinity or bound carbon dioxide (Moyle, 1945). Hardness as parts per million calcium carbonate and parts per million magnesium carbonate has not been measured in other Louisiana lakes, except one study in New Orleans (Poirrier, 1973) where hardness ranged from 8.2 to 12.2 ppm. Hardness in other Louisiana lakes was discussed in terms of total alkalinity.

Procedures used to determine hardness in this study (Hach Model

HA-4P) gave only a relative estimate of hardness and, therefore, a general, but limited picture of the hardness of each lake.

Specific Conductance

Specific conductance closely approximates the residue in solution and is often correlated with chloride concentration or with salinity. For this reason, conductivity is often omitted from the study of fresh waters. Specific conductance in fresh waters can be defined as the total concentration of the ionic components (Reid, 1961). It is, therefore, important to osmoregulation by aquatic organisms and reflects the nutrient availability and buffering capacity of the aquatic habitat (Reid, 1961).

Specific conductance of fresh-water habitats in the United States ranges from 8.9 micromhos/cm for Bunny Lake in the Sierra Nevada (Reimers, 1958) to 60,440 micromhos/cm for Hot Lake in Washington, where it is found to parallel the trends of total alkalinity (Reid, 1961). Specific conductance of alkaline fresh-water habitats in Louisiana is often between 100 and 1100 micromhos/cm (Everitt, 1972; Poirrier, 1969; my observations), with most values ranging between 150 and 400 micromhos/cm. Specific conductance in Louisiana fresh waters is also known to parallel the total alkalinity (Twilley, 1971). Of the limnological studies in Louisiana, only Poirrier's (1973) included conductivity. The range of specific conductance in that pond system was 190 to 420 micromhos/cm. Here the conductivity also reflected the alkalinity.

Specific conductance fluctuations were somewhat regular during this study. Specific conductance decreased at most stations from August to February with a rise in March, and decreased again in April, followed by slight fluctuations through June. These fluctuations closely paralleled rainfall for most periods. Increased rainfall creating surface run-off from the surrounding areas decreased the conductivity of the lakes. The total concentration of the ionic components of the surface run-off of this area is, therefore, obviously lower than that of the lakes. Fluctuations from one month to the next were always less than 50 micromhos/cm in all but Campus Lake, which exhibited monthly fluctuations occasionally exceeding 100 micromhos/cm. Again these fluctuations can often be correlated with rainfall and total alkalinity as expected.

Phosphate

Phosphates occur in trace amounts in many natural waters but are often present in higher concentrations during periods of low productivity. Phosphate concentration should, therefore, be highest during the winter and lowest during the summer due to its uptake by phytoplankton. According to Ruttner (1953), phosphates, in contrast to nitrates, are held by the soil and are not easily leached by rainwater.

Odom (1968) reported relatively low concentrations of phosphates in City Park Lake and Lake Erie. At that time algae were abundant.

Data from my study indicated that concentrations of phosphates in the lake system were very high (0.02 - 4.0 ppm). Therefore, like some other Louisiana lakes (Geagan and Allen, 1960), the phosphate content of the University Lake System would be placed in the category of very good (0.11 - 0.20 ppm) or excessive (2.15 or more ppm) according to Moyle's classification.

The decrease of phosphate in the lake system began approximately four months before that of nitrate. That relationship was expected because phosphate is the only source of phosphorus for biological activity.

Although high phytoplankton activity is often correlated with spring and summer (warmer temperatures), when increased biological processes use much available phosphates, nitrates, and other essential substances (Reid, 1961), data from this study were not consistent with classical trends. Southern Louisiana's mild winters, which extend growing periods and reduce chances for thermal stratification, and frequent rains, which cause continuous circulation, do not permit the expression of clear-cut seasonal changes. This observation was also reported by Bamforth (1963) in other aquatic habitats in southeastern Louisiana, and by Geagan and Allen (1960) in other areas of Louisiana. Texas studies (Harris and Silvey, 1940) also report no correlation between the decrease in phosphate and the increase in phytoplankton. However, most sampling in these studies was done once a month or less frequently. Therefore, the possibility exists that if net phytoplankton, as well as nannoplankton were sampled more frequently and more frequent determinations of phosphate were made over the year, a correlation between those two parameters might be evident.

Ammonia Nitrogen and Nitrate Nitrogen

Because ammonia is a product of oxidative degradation of plant and animal protein, increased concentrations of ammonia nitrogen in natural waters often indicates domestic pollution. In polluted waters ammonia occurs in relatively small quantities, usually 1 ppm or less (Reid, 1961). In natural, unpolluted waters, the ammonia concentration is often less than 0.1 ppm (Rawson, 1939). Under both sets of conditions, however, the ammonia is capable of considerable increase if the dissolved oxygen is decreased (Rawson, 1939; Reid, 1961). Also, the toxicity of ammonia to many fresh-water species increases under alkaline conditions (Reid, 1961).

Unfortunately, only two limnological studies in Louisiana (Geagan and Allen, 1960; Poirrier, 1973) have included ammonia nitrogen determinations. Geagan and Allen (1960) reported an ammonia nitrogen range of 0.04 to 2.54 ppm from Caddo Lake, Cane River Lake, Lake Chicot and Lake Providence, while Poirrier (1973) reported as much as 5.0 ppm from the Audubon Park Pond System. His study, however, included a pond receiving direct run-off from the neighboring zoo which contributed a considerable amount of animal waste.

The University Lake System had a lower ammonia content (0 - 1.85 ppm) than other Louisiana lakes. The ammonia concentration fluctuated irregularly at all stations. A similar irregularity was noted by Geagan and Allen (1960), as was a large variation from month to month. This last relationship was not pronounced in the University Lake System.

According to Rawson (1939), the concentration of nitrates in natural waters is relatively small, usually less than 0.5 ppm. In unpolluted waters, the world's average nitrate nitrogen concentration is 0.3 ppm (Reid, 1961).

Odom (1968) reported relatively low concentrations of nitrates from City Park Lake and Lake Erie. During this study, the nitrate concentrations in the lake system ranged from 0 to 0.9 ppm. The concentrations probably occurred in the surface waters as the final stages of biological oxidation, as well as from surface run-off from the fertilized lawns and golf course in the surrounding area.

Geagan and Allen (1960) reported that the monthly variation of nitrate nitrogen was much less than that of ammonia. They noted an increase in nitrate nitrogen during the winter and extending into the early spring. The mean nitrate concentration in their study was 0.11 ppm for Caddo Lake and Lake Chicot and 0.08 ppm for Cane River Lake and Lake Providence. There was a general tendency for a slight increase in nitrate concentration during October, November and December. At most stations nitrates decreased in January and remained at 0 ppm throughout the end of the study. This decrease, which began after that of phosphate, was also inconsistent with classical studies and is unexplained.

Hydrogen Sulfide

Hydrogen sulfide is usually found where there is natural decomposition of wastes as a result of bacterial and/or chemical processes, and is highly toxic to aquatic organisms in other than trace amounts (Hynes, 1971). Beerman (1924) has shown that hydrogen sulfide can penetrate living cells easily and produce intracellular acidity in acid, neutral and slightly alkaline media. Perhaps the effects of hydrogen sulfide are more important than realized, even in small amounts (Welch, 1952).

Because hydrogen sulfide is unstable in the presence of oxygen, it is readily oxidized to sulfuric acid and, therefore, is given little attention in most surface water analyses. Hydrogen sulfide has not been measured in other limnologically studied lakes in Louisiana. The determination of hydrogen sulfide is usually limited to the hypolimnion of deeper lakes or to sea waters and brackish waters, which are prone to the formation of hydrogen sulfide in the absence of dissolved oxygen because of their sulfate content (Ruttner, 1953). According to Welch (1935), however, lakes and ponds are occasionally found in which the formation of hydrogen sulfide is so great that brass parts of limnological instruments are heavily tarnished on a single submergence.

The hydrogen sulfide content of the surface waters of the University lakes varied monthly and irregularly (Appendix A) from 0 to 0.1 ppm and showed no correlation with the other measured parameters. The high dissolved oxygen concentrations in the University Lake System apparently prevented the accumulation of the unstable hydrogen sulfide. This would also be expected in other Louisiana lakes of high dissolved oxygen content.

Although surface concentrations of hydrogen sulfide in Campus Lake are no greater than those in the other lakes, slight agitation of the massive leaf litter deposits in the lake bottom released large bubbles of hydrogen sulfide along with oil rings produced by bacterial action on the fallen vegetation. Since *Hydra americana* seems to thrive well in the lakes, hydrogen sulfide and other toxic gases are obviously not a problem in the presence of the normally high dissolved oxygen content of these lakes.

Apparent Color

Although true color is due to materials in solution, apparent color can be caused by substances in solution, as well as suspended matter. Apparent color is, therefore, considered to be a good indicator of pollution created by such dissolved substances. A high color quality can restrict light penetration and thus significantly reduce the productivity of an aquatic habitat.

Color values in the United States range from 0 PCU in Crystal Lake, Wisconsin (Mortimer, 1956) to greater than 1000 PCU in many Louisiana fresh-water habitats (Bordelon, Biology Department, LSU, New Orleans, personal communication). Color has not otherwise been reported in limnological studies of Louisiana lakes, except by Geagan and Allen (1960), who reported a decline in color in early spring. This trend was also noted in the University Lake System at which time there was a slight decrease in iron.

Color values (Table I) as low as 15 PCU were reported from Campus Lake (January), whose highest color value was 225 PCU (March). The highest color value for the system was 450 PCU reported from College Lake (October), whose lowest color value was 17 PCU (January). The color range for the interconnected lakes was 70 to 265 PCU.

The relatively high iron content (to 1.1 ppm) contributes significantly to the high color qualities of the University lakes. Soluble calcium carbonates, quantities of which impart a green color to natural waters (Welch, 1935), also contribute color in these lakes, as does manganese. None of these parameters, however, can be directly or singularly correlated with the color value of these lakes. Hach Chemical Company (1967) suggests that the color of water may be quite pH-dependent. However, because pH fluctuated irregularly this relationship was not evident in this study. Allochthonous plant debris is also an important color contributor to the lakes, as is the autochthonous debris consisting primarily of <u>Colocasia</u> and <u>Eichhornia</u>.

Turbidity, Transmittance and Transparency

Turbidity is due to planktonic organisms and non-living matter suspended in natural waters. Many limnologists suggest that turbidity is a major factor in reducing productivity in waters (Harris and Silvey, 1940). Per cent transmittance and Secchi transparency are a function of the turbidity as well as the true and apparent color of the water.

For most months turbidity fluctuated directly with color and total alkalinity. The turbidity range for the interconnected lakes was 10 to 75 JTU. The highest turbidity value (140 JTU) was recorded from College Lake in October, when the color value (450 PCU), total hardness (137 ppm) and specific conductance (180 micromhos/cm) were also high. An opposite relationship between conductivity and turbidity has been observed by Keeton (1959) in Oklahoma, where waters of high conductivity were less turbid than waters of low conductivity. This difference in conductivity - turbidity relationships, however, may be due to the source of the conductivity, which in the Oklahoma ponds was due to chlorides.

Transmittance throughout the University Lake System varied little during the study (Appendix A). Highest transmittance (100%) was recorded from Campus Lake in December and January, while lowest transmittance was 71% from College Lake in October during a dense algal bloom. Per cent transmittance has not been measured in other

Louisiana studies, probably because the Secchi disk is easily handled in the field and, therefore, preferred in measuring light penetration.

Secchi transparency ranged from 9 to 18 inches throughout the lake system. Highest and lowest values were recorded consistently from Lake Erie and College Lake, respectively. These lakes maintained small and large plantonic communities, respectively. Low Secchi disk readings are common throughout Louisiana (Fuss, 1959; Geagan and Allen, 1960; and Poirrier, 1973), where the transperency has been reduced by dense plankton, silt and detrital particles, or humic acids.

The high turbidity (low transmittance and low transparency), which decreases light penetration in the University Lake System, is due primarily to the planktonic components and less to silt, detrital particles and dissolved buffering compounds. Harris and Silvey (1940), however, have found that in some lakes the turbidity is high during high productivity, while in other lakes it is low.

Metallic Elements

Hutchinson (1957) maintains that the metallic elements copper, manganese, molybdenum, zinc, lead and chromium are all probably less concentrated in lake waters than is iron. Such a relationship did indeed occur during this study. However, because atomic absorption analysis was available only in November, no statement of the relationship between these elements and season or phytoplankton abundance is possible. Only iron and copper were determined on a monthly basis (see Materials and Methods).

Iron

In natural, well aerated surface waters, the concentration of iron is usually low because the soluble iron is readily oxidized to the insoluble form. According to Reid (1961), in epilimnetic regions of most lakes the iron content is usually less than 0.2 ppm. Studies by Louisiana Wild Life and Fisheries Commission (1964 and 1969) of the surface waters of five Louisiana lakes revealed iron concentrations of less than 0.6 ppm in all 51 samples. Iron concentrations in the University Lake System exceeded 1.0 ppm; the annual range was 0.4 - 1.1 ppm.

There were correlations between iron concentrations and water color following other seasonal changes, in particular the pH (Appendix A). High concentrations of iron coupled with high color values indicate a watershed containing considerable iron and much surface run-off from areas of decaying vegetation.

Molybdenum

Although molybdenum plays roles in both molecular nitrogen fixation and nitrate assimilation, its usual concentration is extremely small (Hutchinson, 1957). Molybdenum has been shown to be a limiting factor in primary productivity (Goldman, 1960). In seven of twentyfour samples Braidech and Emery (1935) reported only traces of molybdenum. The University lakes yielded molybdenum concentrations of less than 0.5 ppm for all six lakes. Testing methods for molybdenum were refined only to detect a concentration greater than 0.5 ppm and, therefore, were only of relative value.

Manganese

According to Hutchinson (1957), manganese occurs in nearly all surface waters. Nothing is known about the forms of manganese in surface waters. Concentrations of manganese in the lake system were 0.05 - 0.30 ppm. Campus Lake and University Lake exhibited the low and high extremes, respectively.

Copper

Little attention has been given to the presence of copper in lake waters. According to Hutchinson (1957), the mean copper content of waters with a pH above 8.0 is likely to be approximately 32 mg. $m.^{-3}$. Concentrations of less than 0.01 ppm copper were reported for all six lakes in November, while concentrations of 0.2 - 0.5 ppm were reported for other months (Appendix A).

Zinc

The presence of zinc in inland waters has also been given little attention, and zinc is probably present in concentrations at least as great as those of copper (Hutchinson, 1957). In November, zinc concentrations were less than 0.01 ppm at stations 1, 2, 3 and 4; 0.01

ppm at station 5 and 0.02 ppm at station 6. These data, therefore, lend additional support to Hutchinson (1957).

Lead

In natural waters the concentration of lead has been low, but variable, 20 - 400 ppb (APHA, 1971). The presence of very low concentrations of lead is often due to lead pipes or various industrial and mine wastes. All six lakes of the study contained less than 0.1 ppm lead. Methods for lead determinations were refined only for concentrations greater than 0.1 ppm.

Chromium

Chromate concentrations in surface waters usually range from 0 - 2.3 ppm (Cass and Folders, 1957). Chromate was reported in Louisiana lake waters (Louisiana Wild Life and Fisheries Commission, 1964 and 1969) in concentrations ranging from 0.10 - 0.15 ppm. In November, the University lakes at stations 1, 2, 3, 4, and 6 contained less than 0.01 ppm chromium, and 0.01 ppm at station 5. These data represent values slightly lower than other determinations of chromium in Louisiana surface waters.

Relative Stability

Relative stability (APHA, 1955) is the ratio of oxygen available (dissolved oxygen, nitrate and nitrite oxygen) to the total oxygen required to satisfy the biochemical oxygen demand (BOD). Relative stability, however, is often neglected in the literature in favor of the BOD, a measure of oxygen consumed by the biochemical oxidation of organic matter. I know of no other limnological studies that included relative stability.

"Polluted" is a word often used to describe the lakes of the University Lake System. The waters are dark and turbid with various sestonic components and on occasion have a fishy or earthy odor, all adding to the "polluted" appearance. Although the lakes apparently have high biochemical oxygen demands, relative stability tests indicated that on most occasions the lakes had relative stabilities greater than 99% and were very capable of meeting their BOD. Monthly tests showed (Fig. 19) that the interconnected lakes had similar relative stabilities and the highest (99%) for the system. These relative stability tests lend strong support to the absence of sizable and problematic contributions of domestic wastes from homes in the vicinity of the lake system.

In Campus Lake, the most eutrophic lake, the relative stability showed a pronounced decrease from January to March (greater than 99% to 50%). This decrease is not surprising, however, because Campus Lake maintained relatively high values for most other parameters (Appendix A). This lake was subject to campus and stock barn run-off and considerable leaf litter. In addition, February, March and April were months of increasingly heavy rainfalls. April's rainfall (10.1 inches) was 5.7 inches above the average rainfall for that month.

This increase of water from direct rainfall and area run-off helped to dilute the eutrophic condition, increasing the efficiency (99% relative stability) of Campus Lake during the month of April.

According to Odom (1968) sewer systems in the immediate area of City Park and University lakes spill over into the lakes during times of exagerated rainfall. Such an influx probably occurred in April, when the relative stabilities for these lakes dropped from 99% to 37% at station 4, 99% to 50% at station 3 and 99% to 84% at station 2. Stations 4, 3 and 2 represented points of increasing distances from those areas probably affected by sewer spillover. By mid-May all stations had recovered to 99% relative stability.

Community Metabolism and Productivity

Biological productivity has been stated by Welch (1935) to be "the central influence of limnology." Of the limnological studies in Louisiana, few (Moore, 1950 and 1970; Sublette and Sublette, 1957; Pesnell, 1971) contribute to our knowledge of productivity or community metabolism of fresh-water ecosystems in this area. There are, however, studies which have contributed much to the knowledge of Louisiana estuarine productivity, particularly in the coastal region, by the department of Marine Sciences at Louisiana State University in Baton Rouge.

Rawson (1939), in an effort to determine the physical and chemical factors influencing the metabolism of a lake, established criteria for two lake types, eutrophic and oligotrophic. He suggested that slight depth, smaller area, V-shaped bottom contour, higher temperature and plentiful nitrogen, phosphorus and calcium are conducive to eutrophy, while greater depth, larger area, U-shaped bottom contour, lower temperature and smaller supplies of nitrogen, phosphorus and calcium are conducive to oligotrophy.

The University Lake System is located in the rich soils of Mississippi River alluvium, and has a cypress - tupelo-gum swamp history. The lakes are shallow (less than 7 feet), allowing for circulation by wind and rain, have a uniform basin, a cumulative area of less than 350 acres, and consists primarily of trophogenic zone, the activity of which is complemented by Louisiana's mild temperature. Chemical determinations indicate high levels of dissolved oxygen, bicarbonates, carbonates, iron, phosphates, nitrates and calcium. Therefore, based on an evaluation of those parameters, the University Lake System is an eutrophic, actively metabolizing ecosystem.

Primary productivity, the rate of energy storage by photosynthesis and chemosynthesis in the form of organic substances (Odom, 1969), is a function of phytoplankton, filamentous algae, macrophytes or any combination of them. According to Tressler (1939), the limnological measurement of the "usefulness" of a lake is based upon its production of plankton. Prescott (1939), however, stated that large aquatics and land flora surrounding lakes contribute as much or more food to the fauna as does phytoplankton.

Five methods were employed in estimating community metabolism: diel fluctuations in dissolved oxygen, pH, free carbon dioxide and phenolphthalein (bicarbonate) alkalinity (Fig. 3-7, 15-18), and incubation of water samples in light and dark bottles. King (1970) stated that, in general, more enriched (polluted) bodies of water exhibit greater diel fluctuations in dissolved oxygen concentrations. One could, therefore, expect increased metabolism to result in increased diel fluctuations of dissolved oxygen as well as pH, free carbon dioxide and phenolphthalein (bicarbonate) alkalinity, all of which vary directly as a function of photosynthesis and respiration.

The five diel studies during this investigation lend strong support to an accelerated community metabolism, which, according to King (1971), increases the turnover rate of carbon and results in an increased standing crop of algae. Primary productivity in the University Lake System is primarily a function of the phytoplankton communities rather than filamentous algae and hydrophytes. Great importance is attributed to the phytoplankton because it is directly used by zooplankton, many bottom-dwelling organisms and some fish, particularly the gizzard shad which is in great abundance in the lake system. These phytoplankton may, however, be detrimental to the organisms in the lakes during overcast summer days, when the respiratory activities and decaying processes of the phytoplankton consume considerable amounts of oxygen.

Measurements of primary productivity indicated the presence of a very large and active phytoplankton community. Periods of high productivity in University Lake corresponded to warmer temperatures. Of the months observed, December showed the lowest net primary production corresponding to the low water temperature (10°C) during that period.

Productivity is often measured in terms of fish production (secondary and tertiary production). Hart, Doudoroff and Greenbank (1945) reported that in the United States 5% of the waters supporting a "good fish fauna" have less than 40 ppm bicarbonate, 50% have less than 90 ppm, and 95% have less than 180 ppm. The bicarbonates of the University Lake System ranged from 5 to 287 ppm. Fish production in the University lakes, as determined by the Louisiana Wild Life and Fisheries Commission, (Odom, 1968), is presented in the section "Fishes." The sampling revealed optimal and average yields comparable to other Louisiana lakes of similar size.

In addition to the phytoplankton, allochthonous leaf litter and the peripheral Colocasia (autochthonous) contributed to the productivity of the lakes. However, based on the physicochemical factors known to affect lake metabolism, the studies on primary productivity, the numerous and varied organisms in the lakes, and the relative stability of the lakes, the University Lake System is a eutrophic, autotrophic ecosystem.

Bottom Sediments

The soils surrounding the University Lake System are typical of the backswamp areas of the Mississippi River floodplain, an area characterized by dark and peaty soils of the Recent epoch (Cox, 1940). The higher areas surrounding the lakes are Prairie or Pleistocene Terrace deposits consisting largely of brownish silty clays. Calcium carbonate deposits are frequent in the surrounding areas.

Due to the extended growing season of southeastern Louisiana, much of the lakes' bottoms are covered with leaf litter in various stages of decomposition. Odom (1968) found that the soft muck deposited in the lakes since their formation was underlain by several feet of soft grey silty clay comprising the original lake bed material. He also found more than 1.5 feet silt deposited in some areas and relatively low concentrations of phosphates and nitrates in bottom sediments.

Bottom sediment analyses made during this study are given in Appendix B. Unusually high extractable calcium, sometimes exceeding 4000 ppm, occurred in Lake Crest and Campus Lake. These were also the areas with the highest soil reactions (pH) and the lowest extractable phosphorus concentrations. There were no correlations between the extractable K - Na and the extractable Ca - Mg concentrations with each other or with the soil reaction.

Organisms of the University Lake System

Algae

Phycological investigations in Louisiana began over a century ago with the activities of Featherman, a Professor of Languages at LSU, whose botanizing resulted in two articles (1871 and 1872) which included algae and vascular plants. The algal contributions of Featherman, however, consisted of only scant reports of diatoms and desmids. Later Reames (1907) classified and described the freshwater algae of Louisiana, and concentrated on general descriptions of higher taxa (division/phyla). These three works are primarily of historical significance. Since that time, phycological investigations on Louisiana habitats have been mostly through the efforts of Brown (1930), Prescott (1942), Flint (1946), Taft (1946), Moore (1950) and Bamforth (1963). Of these studies, only Prescott's included the area of the University Lake System. Prescott (1942) reported *Oscillatoria chlorina* and *O. tenuis* on the surface of a pond in City Park and *Pithophora oedogonia* (collected and identified by Dr. Lewis Flint, LSU) in "small lakes in City Park ..... where it was reported to have covered the entire surface of the pond."

Twenty-five years later in a non-technical report to the city-parish government, Odom (1968) again reported and discussed the problem of surface growths of filamentous algae in the lakes. At that time Pithophora, Cladophora and Sirogyra were listed as "the most objectionable members of the biological inhabitants in the City Park Lake." Rhizoclonium and Hydrodictyon were listed as present, but were not considered to be problem algae at that time. Unfortunately, no phytoplankton was identified during that investigation.

Of the studies on Louisiana lakes, only Moore's (1950) considers the algal community in any detail. The algal community of the University Lake System does not, however, resemble that of Lake Providence. Moore (1950) reported a predominately blue-green flora (Chroococcus spp., Anabaena spp. and Lyngbya limnetica) in Lake Providence, supplemented with chlorophytes, diatoms and flagellates. Other lakes in the South, however, do maintain algal communities (predominately cyanophytes and chlorophytes) similar to those of the University Lake System (Shannon and Brezonik, 1972). Prescott (1951) states that lakes rich in bound carbon dioxide and having a high pH usually have equal numbers of cyanophytes and chlorophytes. The algal flora and chemistry of the University lakes supports that contention.

The phytoplankton of the University Lake System consisted largely of blue-green and green algae (Appendix C). According to Rawson (1939), the presence of a large blue-green algal flora is an almost certain indication of a high organic waste content. Campus Lake supported an almost continuous bloom of Anabaena from mid-August to mid-September. This period also showed a relative increase in Arthrospira, Pandorina and Gonium. Anabaena blooms were also frequent in College Lake. This study supports the contention of Hutchinson (1944) and Pearsall (1932) that blue-green algal blooms developing in late summer arise when the content of inorganic nutrients is lower.

Euglena blooms occurred infrequently during early September around the north and northeast periphery of City Park Lake. These blooms occurred several days after a major fish kill and were probably supported by the increase in carbon dioxide and nutrients made available by the decaying fishes. According to Brown (Botany Department, LSU, personal communication), this area has also supported large populations of blue-green algae during periods of high organic nitrogen concentrations.

Seasonal variations of algae were not observed. I agree, therefore, with Hutchinson (1944) that, in general, clear-cut correlations between chemical conditions and the qualitative composition of the phytoplankton are not to be expected. Also, according to Bamforth (1963), because winter temperatures in Louisiana fluctuate widely, many phytoflagellates undergo fluctuating population surges and, therefore, do not form ecological successions similar to those of more temperate climates.

Filamentous algae forming mats or otherwise obvious accumulations in the lakes were Cladophora, Oedogonium, Oscillatoria, Spirogyra and Tribonema. Although in previous years, certainly through 1968, Pithophora was a serious problem in City Park Lake and Lake Erie, today there are no signs of Pithophora in any of the lakes. Apparently the algacides used in the late sixties were quite effective in eradicating this problem genus. At present the only problem alga is Oscillatoria limosa, which forms subsurface mats primarily in Campus Lake. These mats fragment after agitation by the frequent cold spring rains and surface. The mats give an unaesthetic appearance to the lake.

Although the lakes, particularly Campus Lake, have large deposits of allochthonous leaf litter, the trophic structure is not detritus-based. The lakes exhibited a phytoplankton-based trophic structure. They are autotrophic ecosystems.

"Sewage fungi" is a broad term applied to colonial bacteria and protozoans as well as true fungi. Although no attempt was made to identify the fungi, masses were often noted on twigs, roots and similar substrates. The genus most often encountered in the lakes, however, was probably Sphaerotilus, a colonial bacterium. There have also been periodic reports of fungal-like growths on the fishes prior to fish kills. This observation may be of particular interest in later investigations involving the annual fish kills in the lakes.

Cyanophyta

Agmenellum quadriduplicatum was frequent in the interconnected lakes during September. It was also a frequent component of the algal flora after fish kills. According to Smith (1950), although frequent, *Agmenellum* is never an important component of fresh-water plankton. This study suggests that *Agmenellum*, as well as other blue-green algae, increase with the availability of free carbon dioxide (lower pH) following fish kills and are perhaps better able to compete than other algal groups.

Anabaena spiroides was abundant in all lakes throughout the year. Algal blooms of *A. spiroides* were frequent throughout the year in Campus Lake and College Lake, especially during the warmer months. Moore (1950) found *A. spiroides* abundant in Lake Providence where its maximum growth occurred in July and its minimum during the winter months.

Anabaenopsis circularis was frequent throughout the year in the lake system and abundant after fish kills in City Park Lake. It occurred less frequently in Campus and College lakes during *Anabaena spiroides* blooms. Perhaps competition between these two algae for similar nutrients resulted in the decrease of *Anabaenopsis*.

Anacystis cyanea was infrequent throughout September in City Park Lake and frequent in October in Campus Lake. It was also collected from University Lake along the western shore during September, when local blooms occurred among *Ludwigia peploides* floating at the surface. The absence of *A. cyanea* in those lakes during other months is unexplained.

Arthrospira jenneri was infrequent throughout September in City Park Lake. Its absence during other months throughout the system is unexplained.

Species of Oscillatoria commonly form mats in southern Louisiana (my observations). Oscillatoria tenuis and O. chlorina were reported from City Park Lake in 1938 (Prescott, 1942). My plankton samples contained frequent, broken filaments of Oscillatoria from all lakes throughout the year. Oscillatoria limosa occurred in small floating mats in Campus Lake during the early spring. Oscillatoria limosa filaments were abundant in plankton samples during Anabaena spiroides blooms in September in Campus Lake, and frequent throughout the rest of the year. Oscillatoria appears to favor and to compete well in organically rich areas such as Campus Lake.

An unidentified blue-green alga similar to Romeria occurred frequently throughtout the year in the interconnected lakes.

Chrysophyta

Chrysosphaerella longispina occurred frequently in the interconnected lakes throughout the year. This species is not uncommon in Louisiana (my observations), although it was not found in Campus and College lakes. Perhaps it does not compete well with the cyanophytes which were abundant in those lakes.

Planktonic diatoms were frequent in all lakes throughout the year and infrequent after fish kills in City Park Lake. This slight decrease was possibly due to the inability to compete successfully with the cyanophytes and chlorophytes which were more abundant at that time. Navicula, Fragilaria and Frustulia, although encountered infrequently, were the most common diatom genera in the lakes. Navicula was rare after fish kills. Epiphytic diatoms were common on filamentous algae; petioles, roots and leaves of hydrophytes; and submerged twigs where they formed a brown coating.

Tribonema bombycinum was found infrequently in the interconnected lakes from March through June. This alga formed small mats along the shorelines. Tribonema bombycinum, like the other filamentous algae, served as a substrate for various microorganisms. It is not uncommon in Louisiana (my observations).

Chlorophyta

Actinastrum gracillimum was infrequent in City Park Lake, where it was collected before and after fish kills in September. Its absence in City Park Lake at other times of the year and in the other lakes throughout the year is unexplained.

Ankistrodesmus falcatus was abundant throughout the study in the interconnected lakes. It was present before and after fish kills in September. However, according to Smith (1950) in the wide variety of habitats from which it is known, A. falcatus is rarely in abundance.

Chlamydomonas was encountered infrequently in the interconnected lakes throughout the year. Chlamydomonas was frequent in College Lake during March and infrequent during the rest of the year. Several species of Chlamydomonas are found frequently throughout the year in the hard and soft waters of southeastern Louisiana (Bamforth, 1963).

Chlorella was encountered frequently in City Park Lake during September, and infrequently throughout the year in the interconnected lakes. Chlorella was not collected from Campus and College lakes.

Perhaps Chlorella is not able to compete with the dense growth of cyanophytes present in the lakes throughout the year.

Cladophora species commonly form mats in both brackish and fresh waters in southern Louisiana. Such mats often cover the entire surface of a pond (my observations). Cladophora was listed by Odom (1968) as one of the three most frequently occurring filamentous genera in City Park Lake and Lake Erie. Chemical control of Cladophora in those lakes was attempted several times with little success (Odom, 1968). I found Cladophora (not fruiting) infrequently, attached to concrete slabs and in small mats along the shorelines of the interconnected lakes. This genus does not exist in problem proportions in the lake system today, although it is present throughout the year. Perhaps its growth is being controlled by the dense growth of phytoplankton found in the lake system.

Closterium, one of the frequently encountered desmids and several species of which are to be found in hard waters (Smith, 1950), was present throughout the year in the lake system. C. moniliforme was infrequent throughout the year.

Cosmarium was encountered infrequently throughout the spring and summer in College Lake and infrequently in City Park Lake before and after fish kills. In March and April, College Lake had a lower pH. City Park Lake also had a lower pH following fish kills. According to Whitford and Schumacher (1969), desmids favor a pH range of 5.4 to 6.8. Perhaps the lower pH favored the growth of Cosmarium during those periods.

Gonium pectorale was abundant only during the late summer in Campus Lake, and occurred infrequently during the rest of the year. It was also collected infrequently in the interconnected lake throughout the year. Gonium pectorale is a common species in southeastern Louisiana, where it occurs frequently in hard and soft waters throughout the year.

Microspora amoena occurred infrequently along the shoreline of University Lake where it formed small mats throughout the year. It was not encountered in the other lakes. It is difficult to explain this absence because this species is a common mat-former in physicochemically similar habitats in southern Louisiana (my observations). According to Smith (1950), it is more often encountered during the cooler months, but I found no such increase.

Oedogonium (not fruiting) occurred mixed with filaments of Spirogyra. Oedogonium was collected from the interconnected lakes where it was infrequent throughout the year. The scarcity of Oedogonium in the University Lake System may be due to the eutrophic condition of the lakes because according to Whitford and Schumacher (1969) Oedogonium prefers clear water lakes and ponds of low mineral content.

Pandorina morum was collected frequently during September in the interconnected lakes, and infrequently during the rest of the year. It was also frequently encountered in Anabaena spiroides blooms in Campus Lake throughout the year. Bamforth (1963) considers

P. morum to be a common species in southeastern Louisiana where it is found frequently in hard and soft waters throughout the year.

Pediastrum simplex, and one or more species with two projections per outer cell, were collected frequently in City Park Lake during March, and infrequently in the other lakes throughout the year. March was a period of high pH, chloride and total alkalinity in City Park Lake. According to Prescott and Vinyard (1965), the hardiness of Pediastrum species is well known, as is their association with mostly hard water and the more productive type of lake.

Species of Pithophora in southern Louisiana commonly form mats which often cover the entire surface of a pond. Pithophora sp. was listed by Odom (1968) as a mat-forming alga in City Park Lake and Lake Erie. Chemical control of Pithophora was attempted several times with little reported success (Odom, 1968). I found no Pithophora in the University Lake System during this study, although the physicochemical nature of these lakes very closely resembles that of New Orleans' Audubon Park Pond System (Poirrier, 1973) which is currently covered with a dense surface layer of Pithophora.

Rhizoclonium was reported in City Park Lake by Odom (1968). I found no Rhizoclonium during this study.

Scenedesmus species (S. quadricauda, S. dimorphus, S. acuminatus and S. abundans) were frequent in the interconnected lakes and infrequent in Campus Lake throughout the year. According to Moore (1950), Scenedesmus was the only genus present throughout the year in Lake

Providence, where members of the genus appeared more abundant in the winter. In the University Lake System, as well as in Lake Providence, S. quadricauda was the most abundant of the Scenedesmus species.

Spirogyra (not fruiting) was infrequent throughout the year in the interconnected lakes, where it was collected from concrete slabs and Colocasia petioles along the shorelines. Spirogyra was also intermixed with filaments of Oedogonium. These two genera formed small mats along the shorelines. Morphology suggests that there may be more than one species of Spirogyra in the lake system. According to Smith (1950), Spirogyra is one of the most common green algae in quiet waters.

Staurastrum was collected only once from City Park Lake in September. Smith (1950) considers Staurastrum to be the most common desmid in fresh-water plankton. The University Lake System might, therefore, represent borderline physicochemical conditions for this genus because desmids are found mostly in acid, soft waters, the most favorable pH range being 5.4 to 6.8 (Whitford and Schumacher, 1969).

Euglenophyta

Euglena (probably E. spirogyra) was frequent throughout the year in all of the lakes. A bloom of Euglena (probably oxyuris) occurred near the northern end of City Park Lake in mid-September. The run-off received from the city's golf course probably increased the available nutrients in that area. E. oxyuris was not otherwise noted in the lakes. Also in September, _E_. _spirogyra_ was more abundant in Campus Lake during an _Anabaena spiroides_ bloom. The euglenoids are favored by warmer weather and are abundant in the hard waters south of Lake Pontchartrain in southeastern Louisiana (Bamforth, 1963). Bamforth (1963) reported _E_. _oxyuris_ and _E_. _spirogyra_ from that area at which time _E_. _spirogyra_ was the more common euglenoid.

Vascular Plants

The first recorded investigation of aquatic plants in the area of the University Lake System was a survey of the grasses of East Baton Rouge Parish by Thompson (1933) in which he discussed the "College Town swamp" as a type of habitat. The following year, Velez (1934) studied the succession of plants in that same area which had been recently cleared for the impoundment of the lakes. Velez reported that that area had probably been covered with trees and shaded for at least the last three hundred years. Also at that time, Howe (Geology Department, LSU) made soil borings in the area and concluded that the age of the swamp could be measured in hundreds of years and that there was "no way of determining even its approximate age."

These floral studies, however, are more of historical value, than tools for interpreting plant succession in and around the lake system, which has been recently created by man following his destruction of the original swamp habitat.

After reviewing specimens in the Louisiana State University Herbarium (LA), several species collected from the area of the University Lake System prior to the studies of Thompson and Velez were found. Plant collections date back as early as 1899 with specimens of _Bumelia smallii_, _Solanum carolinense_, _Gonolobus laevis_ and _Asplenium platyneuron_. Other collections from the area include _Iva annua_, _Trillium_ sp., _Polypremum procumbens_, _Physalis angulata_, _Planera aquatica_, _Senecio lobatus_, _Leptochloa filiformis_, _Cyperus virena_ and _Fimbristylis littoralis_. All other records of vascular plants from the area of the University Lake System seem to be the efforts of Brown (Botany Department, LSU), who botanized in the state for a half century. His collections in association with the lakes consist of _Cyperus compressus_, _C. erythrorhizos_, _C. jenugenescens_, _C. brevifolia_, _C. rotundus_, _C. strigosus_, _Fimbristylis autumnalis_, _Aechynomene indica_, _Hydrocotyle ranunculoides_, _Lilaeopsis carolinensis_, _Utricularia gibba_ and _Phoenix canariensis_.

My survey of this area consisted of the collection and identification of 84 species of vascular plants, 37 species (Appendix C) of which were in direct contact with the waters of the University Lake System throughout most of the year. None of the species are actually rooted in the lake basins, however, except _Taxodium distichum_, a species attesting to the cypress-tupelo gum swamp history of the area.

The most abundant emergent species is _Colocasia antiquorum_. Other emergent plants are _Taxodium distichum_, _Alternanthera philoxeroides_, _Eichhornia crassipes_, _Saururus cernuus_, and various members of the Juncaceae, Cyperaceae, Poaceae and Onagraceae (Appendix C).

The floating plant populations consisted of only four species: *Eichhornia crassipes*, *Lemna minor*, *Spirodela polyrhiza* and *Ludwigia peploides*, none of which occurred in other than local abundance. According to Odom (1968), several years earlier, duckweeds formed the principle surface growth on Lake Erie, which is today free of these tiny floating plants. During this study several sizable contributions of *E. crassipes* from unknown sources were set afloat in City Park and University lakes. This plant was from time to time a troublesome species in City Park and University lakes. Several projects were undertaken to remove or eradicate it. One project in 1942, using dredging boats, lasted ten weeks. Other more recent control measures for *E. crassipes* as well as other hydrophytes and algae included applications of various chemical compounds such as 2,4-D, Dal E Rad, Karmex, Ametryne and copper sulfate to name only a few (Odom, 1968).

In the only previous investigation concentrated in the area of the lakes, Velez (1934) reported:

> Excluding the sprouts, a total of approximately 150 species were found, included in 123 genera, representing 44 families. Of the small families, Polygonaceae seems to be most represented, of the large ones, Leguminosae the least represented. Grasses, *Polygonum*, sedges, golden rods, ragweeds, *Alternanthera* and wandering jews are the most prevalent.

Approximately 30 species present in the area of the University lakes today were also present prior to the impoundment of the lake system. The predominant plants presently surrounding the lakes include sedges, grasses and composites. This is a common associes in many areas of Louisiana, and according to Velez (1934) was the prevailing associes in 1934. Other plants present today are common in the Baton Rouge area and throughout southern Louisiana. Only Colocasia antiquorum, a species introduced into the area for its aesthetic value (not reported by Velez, 1934) and forming the dominant peripheral vegetation of the lake system, is uncommon as a weedy species in the Baton Rouge area. Colocasia is, however, established in parts of the state from the Pearl River to the Sabine River (Brown, 1972).

A large and varied plant community is often present in Louisiana lakes. D'Arbonne Lake (Hughs, 1971), Black Lake (Stokes, 1971), Lake Chicot (Lantz, 1971; Eggler and Moore, 1961), Lake LaFourche (Williams, 1971) and Bundicks Lake (Carver, 1971), to name only a few, are often choked by dense vegetation. Lake Chicot, for example has been infested by dense vegetation since its impoundment in 1943 (Gowanloch, 1945; Penfound, 1949; Eggler and Moore, 1961). Troublesome plants in that lake included Cabomba caroliniana, Nelumbo lutea, Brasenia schreberi, Ceratophyllum demersum, Nymphaea odorata, Elodea densa, Alternanthera philoxeroides and Eichhornia crassipes. Other interesting studies on aquatic vegetation in Louisiana lakes are those of Brown (1943) and Liner (1949).

All of the lakes of the University Lake System are presently free from problem hydrophytes. In all lakes there is an absence of submerged vascular plants, which may be due in part to a lack of littoral area as well as to a dense phytoplankton community which prevents light penetration necessary for the establishment of rooted vegetation. Previous reports (Odom, 1968), however, included *Najas* sp. and *Potamogeton* sp. as troublesome plants.

The role played by hydrophytes is always of particular interest. In addition to serving as primary producers in the lakes, the hydrophytes were invaluable to numerous aquatic invertebrates and algal species as substrates. The hydrophytes not only supported the aufwuchs communities, but also contributed shelter, food and support to those organisms living on or completing their life cycles within the aerenchymous tissues of those plants.

Invertebrates

Zooplankton

The zooplankton consisted of rotifers, fragments of Zoothamnium colonies, ectoproct floatoblasts, occasional oligochaetes, rhabdocoels, nematodes, newly hatched odonate nymphs or chironomid larvae, as well as various microcrustaceans such as cyclopoid coepods, nauplius larvae, ostracods and cladocerans.

The interconnected lakes had similar zooplankton communities consisting largely of ectoproct floatoblasts, copepods, nauplius larvae and several species of large rotifers. In contrast, Campus Lake and College Lake had zooplankton communities consisting primarily of rotifers, and cyclopoid copepods and nauplius larvae, respectively. Campus Lake and College Lake also supported a much larger zooplankton community than the interconnected lakes. This was best correlated with the higher concentrations of dissolved nutrients and carbonates which enabled those two lakes to support large phytoplankton communities.

Protozoa

Although protozoans were beyond the scope of this investigation, the colonial protozoan Zoothamnium constituted a predominant species of the aufwuchs communities. Zoothamnium was often closely associated with ectoproct colonies and aquatic insect nymphs, which served as substrates. Common protozoan epiphytes included *Acineta*, *Campanella*, *Epistylis* and *Vorticella*. These ciliates were abundant on the filamentous algae *Oedogonium*, *Cladophora* and *Tribonema*, sticks and bryozoan colonies. Bamforth (1963) considers species of *Vorticella*, *Acineta* and *Epistylis* to be ubiquitous, infrequent to rare and rare, respectively, in southeastern Louisiana.

Porifera

The absence of sponges in the University Lake System was also noted by Poirrier (1969), who observed this area from 1963 to 1969. He believes that the eutrophic condition and dense phytoplankton communities may be responsible for the absence of sponges. Roberts (Dept. of Zoology & Physiology, LSU, personal communication) collected sponges from these lakes many years earlier. He also collected spongilla fly larvae from the sponges.

Coelenterata

Only the fresh-water hydroid *Hydra americana* was collected from the lakes. Individuals were attached to a wide variety of substrates, such as filamentous algae, aquatic insects, ectoproct colonies, sticks, twigs and leaf litter. *Hydra americana* was abundant in the interconnected lakes and Campus Lake. This species was collected in January, March and May.

Platyhelminthes

The class Turbellaria was well represented in the lakes. Only one species of the common planarian Dugesia tigrina (Tricladida) was collected from the interconnected lakes and Campus Lake, where it was abundant throughout the year. Dugesia tigrina was most often associated with Colocasia petioles and Eichhornia roots, which also served as substrates for turbellarian cocoons. Longest (1966) reported D. tigrina from University Lake several times between 1964 and 1966.

The rhabdocoels appeared to be represented by several species; identifications based on serial sections were not attempted. Rhabdocoels were collected from Colocasia petioles, Eichhornia roots, filamentous algae and in plankton samples. In a single lake in which many microhabitats exist, as many as thirty species of rhabdocoels have been reported (Pennak, 1953).

Nemertea

Prostoma rubrum, the only fresh-water nemertean in North America, was first reported for Louisiana from University Lake by Harman (1962). No nemerteans were collected during this study.

Rotifera

Sessile and planktonic rotifers were numerous throughout the year in all lakes. Sessile rotifers were common on twigs and leaf litter, various hydrophytes and filamentous algae. Rotifers of the genus Branchionus were most numerous. Gallagher (1966) believes that members of this genus are more numerous in a relatively neutral to alkaline environment supporting dense phytoplankton. This study supports Gallagher's observations. During early fall in Lake Erie and University Lake, colonial rotifers, believed to be in the genus Sinantherina, formed spherical orange colonies approximately 3-6 mm in diameter. These rotifer colonies were abundant along the shoreline where they were attached to twigs and the bryozoan Plumatella repens which also covered the twigs.

Nematoda

Nematodes were abundant throughout the year in all lakes and were associated with bottom debris and the fauna-rich roots of Eichhornia and Colocasia. They were also frequently collected in plankton samples. Although numerous specimens were collected and observed, only Actinolaimus and Diplogaster were identified.

Ectoprocta

Plumatella repens, a common fresh-water ectoproct in southern Louisiana, was abundant and active throughout the study. This bryozoan occupies most available substrates, including hydrophytes, twig and leaf litter, cans, bottles and automobile tires. Its abundance is not surprising, however, in lieu of the apparent absence of sponges, which according to Everitt (1972) often replace bryozoans on a substrate. All colonies were dendritic. According to Dendy

(1963), where colonies are exposed to fish they are cylindrical, devoid of branches and composed of densely arranged zooids. This study suggests that other organisms in the University Lake System, such as various insect larvae and nymphs, are preferred food sources for fish.

A specimen collected from Campus Lake is believed to be *Hyalinella punctata*. This ectoproct is not previously reported from Louisiana.

Annelida

Aquatic oligochaetes and leeches were present in all lakes throughout the year. Oligochaetes were collected in close association with leaf litter, twigs, roots of hydrophytes and filamentous algae as well as in plankton samples. Oligochaetes of the genus *Aulophorus* were often found in tubes constructed of bryozoan floatoblasts. An oligochaete collected from University Lake in 1964 was later described by Harman (1965) as a new species (*Pristina longidentata*).

Six species of leeches were collected during this study, bringing the number of leeches known to inhabit the University lakes to ten. Leeches were associated with the roots and petioles of hydrophytes, twig and leaf litter and slabs of concrete. Leech cocoons were often encountered on *Alternanthera*, *Eichhornia* and *Colocasia*. *Helobdella stagnalis* and *H. lineata* were the most common and widespread species collected.

The finding of Helobdella fusca and H. stagnalis during this study represents first records of these species in Louisiana. A specimen tentatively identified as Dina parva may also be a first report for Louisiana.

Arthropoda

Arthropods were well represented in the lakes, both in number of species and number of individuals. Common insects included coleopterans, ephemeropterans, dipteran larvae, hemipterans and odonate nymphs. The damselfly numph Ischnura was the most frequently occurring insect in the lake system. Ischnura was present throughout the year. Gyrinids were most abundant during the spring and summer. Tendipedid larvae were present throughout the year. Insect adults and/or larvae were associated with hydrophytes, filamentous algae, twig and leaf litter and the neuston.

The coleopteran Peltodytes and the odonate Brechmorrhoga mendax are uncommon in southern Louisiana. Brechmorrhoga mendax is a possible state record.

The most common crustaceans collected were the isopod Asellus militaris, which was most abundant during March, ostracods, copepods, the amphipod Hyalella azteca and the grass shrimp Palaemonetes kadiakensis, which were common throughout the year. The breeding season of P. kadiakensis in Baton Rouge lakes is discussed by White (1949). The crustaceans were associated with such substrates as filamentous algae, hydrophytes, twig and leaf litter and the neuston. Hyalella azteca was the predominant crustacean and was abundant in the roots of Eichhornia crassipes and Colocasia antiquorum and in the mats of various filamentous algae. Others (Hanson, et al., 1971) have found that the Eichhornia crassipes - Hyalella azteca association is a major macro-producer - herbivore association in the food web where the amphipod is known to feed specifically upon water hyacinth roots. The amphipod was also verified by Katz (1967) and O'Hara (1967) as the predominant metazoan animal in the water hyacinth community.

Mollusca

Alkaline fresh-water habitats like the University Lake System often have a large molluscan fauna. The gastropods included members of the genera Physa, Lymnea, Gyralus, Heliosoma, Ferrissia and a frequently encountered viviparid. The gastropods were collected from hydrophytes, twig and leaf litter, concrete slabs and the neuston. No viviparids were collected alive. All other molluscs were collected throughout the year. Only one bivalve species Anodonta grandis was collected. It was collected only from the interconnected lakes. Molluscs were not present in the abundance expected for an alkaline lake.

Fishes

As already indicated, the history of the fish populations in the University lakes began in January, 1937, when the Louisiana Wild Life and Fisheries Commission first stocked City Park Lake with 10,000 large-mouth bass, 500 sacalait, 5,000 bluegill and 5,000 perch. Since that time, and particularly since the first fish kill in 1948, the fishes and fishing potentials of the lakes have received considerable attention, though not always constructive or long lasting.

Fish censuses were first made in 1955 and again in 1966 in City Park and University lakes by the Louisiana Wild Life and Fisheries Commission. The samplings showed that although the proportions of the fish species were not optimal for sport fishing, City Park and University lakes supported fish populations large enough to yield optimal and average annual catches comparable to other Louisiana lakes of similar size.

In July, 1955, fish samples from City Park Lake yielded an average population of 900 pounds of fishes per acre. Thirty-one per cent of the yield (283 pounds per acre) was game fishes. During the same period, University Lake supported a fish population of only 204 pounds per acre, less than 4.5 times the yield of City Park Lake. The 1966 sampling did not permit density determinations in pounds per acre but did show that the ratio of game to non-game fishes was almost the inverse of that ten years earlier.

During this study, sampling indicated that the fish fauna was represented by a minimum of seven families of which the Centrarchidae was most abundant, both in number of species and number of individuals present. The interconnected lakes were predominated by sunfish and shad populations, while Campus Lake and College Lake had a fish community consisting primarily of the Poeciliidae. In College Lake as many as 570 specimens of *Gambusia affinis* were taken in one 30-foot area with a 25-foot seine. This sharply contrasts with the ten or fewer specimens taken under similar conditions in the interconnected lakes.

No young bass were collected in seines during this study. This probably indicates that although the lakes were originally stocked to support bass fishing, bass are no longer the major predators in the food chain. The natural predator - prey relationship of the bass and bluegill populations has been upset by overfishing of the bass. Consequently, the *Lepomis* community appears to be controlled mainly by fishing.

Fish Kills

That the University lakes are operating at their maximum capacity is evidenced by any of the massive fish kills, which are an almost annual occurrence in one or all of the four interconnected lakes, particularly City Park Lake. According to Robert LaFleur, head of Louisiana Stream Control Commission, fish kills have occurred annually on these lakes for the past quarter century. The first fish kill on record (State Times - Morning Advocate morgue*) for the lake system occurred in University Lake in late May, 1948. At that time the lake was only ten years old. After the emergence of dead fishes, two water samples from the Stanford Avenue area and one from the Dalrymple Drive area were tested for dissolved oxygen content, which was 2.6 ppm. Although this concentration of dissolved oxygen does not suggest lethality, low dissolved oxygen was nevertheless credited to be the critical factor in the fish kill. The shad were the first fish to surface and die. They were followed by bass and sacalait. "All mussels" were also reported to have been eliminated at that time.

Since that first fish kill in 1948, the following fish kills have been recorded (State Times - Morning Advocate morgue) during the summer and early fall periods over the past twenty-five years.

* These data were probably not all inclusive.

Unfortunately, in most cases, information other than the dates and locations of the fish kills was not recorded.

early August, 1956 - Fish kill in Lake Crest; six dead fish reported in City Park Lake and the two small lakes to the east (Lake Erie and private pond).

mid-June, 1963 - University Lake following drought.

late June, 1963 - University Lake.

late July, 1963 - University Lake.

late August, 1965 - University Lake (8 tons of fish were removed; 90% shad, 7% bream, 2% catfish, 1% buffalofish and eels).

early August, 1968 - University Lake.

early August, 1969 - City Park Lake.

mid-August, 1970 - University Lake and City Park Lake

late June, 1972 - University Lake.

mid-August, 1972 - City Park Lake.

early September, 1972 - City Park Lake.

mid-September, 1972 - City Park Lake (3 truckloads of fish were removed. The fish were mostly shad. There were also bream, catfish and several large carp).

During the twelve months of this study, three fish kills occurred. These and most previous fish kills have been thought to be due to a lack of dissolved oxygen in the water with one of the following proposed as the cause for the oxygen depletion: phytoplankton blooms dying during an overcast day and depleting the oxygen by their decaying processes; the shallow depth of the lakes, especially during the summer months; and domestic sewage. Other fish kills have been attributed to the chemical eradication of floating mats of the water hyacinth _Eichhornia crassipes_ or the alga _Pithophora_, which were reported to have covered the lakes from time to time in the past, as well as the runoff of insect poisons from surrounding residences following heavy chinch bug infestations.

The first fish kill recorded during this study occurred in the early morning hours on August 16, 1972, when the dissolved oxygen content dropped to about 1.0 ppm (approximately 12% saturation). This fish kill can be explained by the classical "textbook phenomenon" of a cold rain in the afternoon of an otherwise hot day sinking through the shallow warm waters of the lake and stirring the bottom debris, which in turn consumes most of the available dissolved oxygen. This fish kill occurred in City Park Lake only, probably due to the slight depth of the entire lake making it more susceptible to this kind of oxygen depletion. Dead fishes of all sizes, mostly shad, lined the periphery of the lake.

The second fish kill occurred on September 10, 1972, in City Park Lake also but was of a much greater magnitude; the entire surface of the lake was covered with dead fishes. Again shad were in greatest number, although there was considerable species and size diversity among the dead fishes. The odor and unsightly condition of the lake immediately won the attention of concerned Baton Rouge citizens. One person representing Louisiana Wild Life and Fisheries Commission gave the cause as oxygen depletion due to the decay of a previous (and perhaps hypothetical) algal bloom. Although the decay of an algal bloom is usually an acceptable explanation for fish kills in relatively eutrophic lakes, it was probably not the answer to this fish kill. The following alternative explanation (my observation) is offered as the cause for the suffocation of the fishes. During the week prior to the fish kill, the dense growths of Colocasia and Eichhornia, which surround the periphery of the lakes, were chemically treated and left to decompose in the adjacent water. Because this lake is very shallow (26% of the lake is less than 1.5 feet deep, 87% of the lake is less than 3.5 feet, maximum depth is 4.5 feet deep), the excessive amount of decaying vegetation probably depleted the oxygen within several days, which caused the fish to suffocate. That is, because the dissolved oxygen during the early morning hours at that time of the year is between 4 and 5 ppm, such a massive decaying process could have easily lowered the dissolved oxygen content below the minimal requirement for most fishes. In addition, with an increase in carbon dioxide (here due to the decaying process of the vegetation) more oxygen is required to saturate respiratory pigments of the blood (Warren, 1971). The lake is apparently operating at full capacity and any such change would probably upset the balance. After the fish kill on September 11, the lake had completely recovered, and the dissolved oxygen content was up to 11 ppm at mid-morning of September 14.

The third fish kill occurred less than one week later, on September 17, and was less extensive. Following this fish kill there was no noticeable increase in the algal populations, which were again popularly thought to be the cause of the fish kill. The third fish kill, like the first, followed a period of cool afternoon rains, which are known to deplete the dissolved oxygen in the water by stirring the bottom debris. The lake at that time was particularly vulnerable to oxygen depletion due to the excess decaying matter that had settled on the lake bottom as a result of the previous fish kill.

Observations of several fish kills and extensive chemical determinations on the lakes' waters suggest that no one factor has been responsible for all of the fish kills. There is, however, little doubt that the death of the fishes was due directly or indirectly to a lowered dissolved oxygen content. Perhaps this lower dissolved oxygen content, coupled with the other stressful chemical conditions known to contribute to the relatively harsh environment of the lakes, was sufficient to produce toxic effects, particularly at those times when cool summer afternoon rains and hydrophyte or insect eradications had not preceded the fish kill.

According to Eugene Young (Superintendent of BREC) and Odom (1968), solutions for the problem of maintaining a satisfactory dissolved oxygen level have ranged from floating logs in the lakes, to chemical control of the filamentous algae populations, introduction of the tropical fish Tilapia to eat the algal growths, reopening the lakes to speed boats, dredging to increase the lakes' depth and even draining the lakes, drying their beds and burning the residue.

Attempts to control the algae have been many and costly, but somewhat successful. Dredging has been proposed on several occasions and is currently under investigation by the Department of Public Works in an attempt to prevent future fish kills. Deepening the lakes would eliminate the shallow areas which support nitrogenous matter important to algae proliferation, and would possibly lower the temperature of the water and allow it to maintain a higher concentration of dissolved oxygen, particularly during the warmer months.

Physicochemical - Biological Interactions

All physicochemical parameters fluctuated irregularly and were within relatively narrow ranges. Although no clear-cut seasonal trends were evident, pH, specific conductance and alkalinity showed a slight tendency toward seasonality with a simultaneous decrease between December and February. These parameters, however, are functions of each other, and any change in one was expected to be reflected in the others. Although the dissolved oxygen concentration remained relatively high during these months due to the lowered water temperatures, this was also a period of reduced photosynthetic activity.

The apparent stability of the pH and relatively high alkalinity and hardness were due to the abundance of dissolved buffers (carbonates and bicarbonates of calcium and magnesium), a function of the Mississippi River terrace soils in which the lakes were excavated. Free carbon dioxide, when present, varied irregularly at each station but remained low due to active photosynthesis by the phytoplankton.

The decrease of phosphate, which began four months before that of nitrate, was expected because phosphate was the only source of phosphorus for biological activity. Although high phytoplankton activity is often correlated with warmer temperatures, when biological processes use much available phosphate, nitrate and other essential substances, data from this study did not indicate such a trend. The concentration of nitrate probably occurred in the surface waters as the final stages of biological oxidation, as well as from surface run-off from the fertilized lawns and golf course in the surrounding area. The lack of correlation between nitrate concentration and any trends in phytoplankton activity was probably due to fluctuations in the input of nitrate from run-off. The possibility exists that if net phytoplankton and nannoplankton were sampled more frequently and if more frequent determinations of phosphate and nitrate were made over the year, a correlation among those parameters might exist.

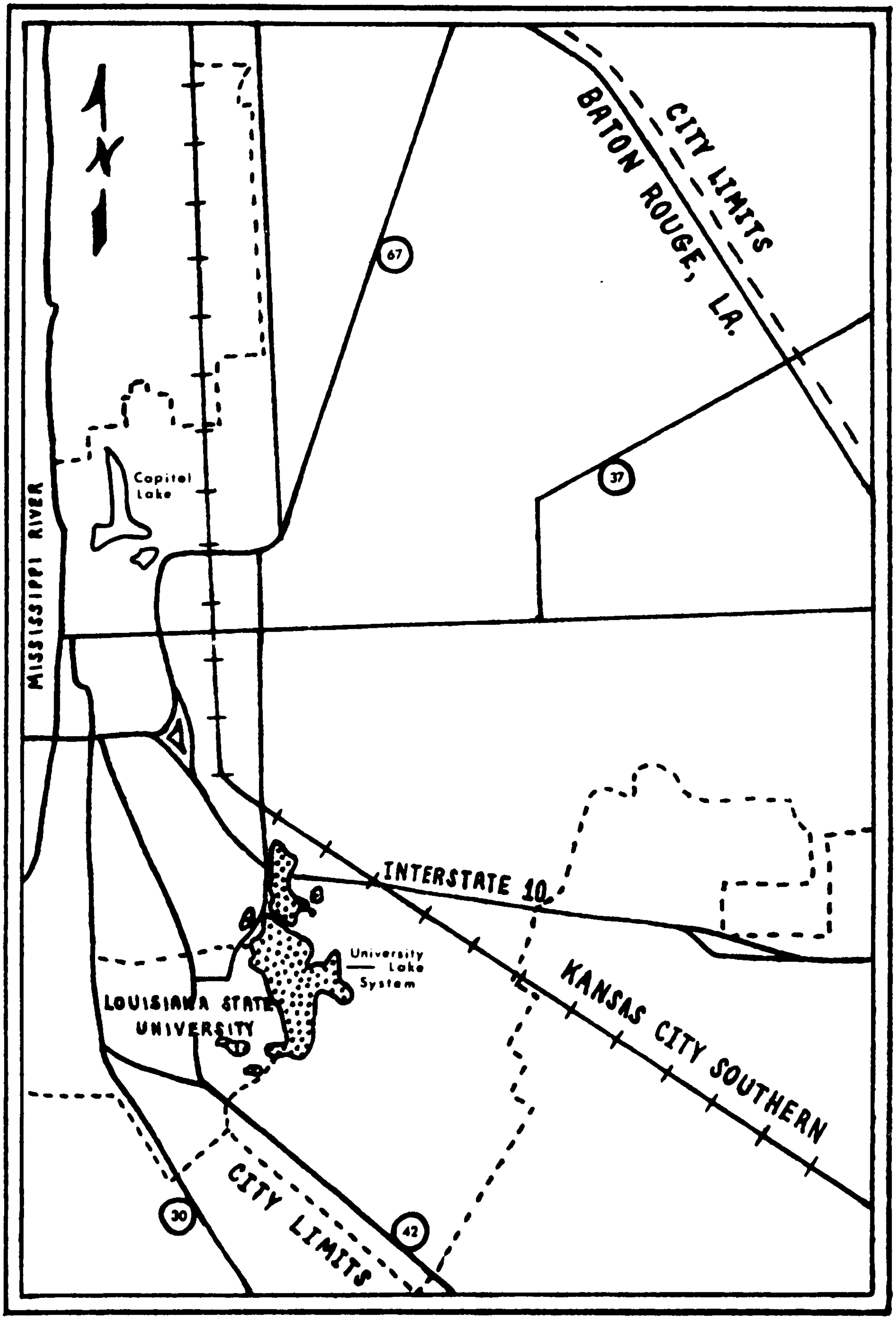
Turbidity, apparent color, transmittance and transparency are all functions of each other and showed the expected high correlation. These parameters correspond to the numerous planktonic components, the high iron content and the dissolved calcium carbonates in the lakes.

The alkaline waters, relatively rich in phosphates and nitrates, supported large plankton communities. Species of <u>Euglena</u>, <u>Oscillatoria</u> and <u>Anabaena</u> frequently formed blooms in the areas of high organic waste content. The interconnected lakes were rich in bound carbon dioxide (primarily bicarbonate), had a high pH, contained equal numbers of cyanophytes and chlorophytes (except during algal blooms) and relatively equal numbers of rotifers, copepods and nauplius larvae. Plankton in College Lake consisted mainly of cyanophytes, copepods and nauplius larvae. College Lake had a high pH and was rich in bound carbon dioxide due to both carbonates and bicarbonates. Plankton in Campus Lake consisted primarily of cyanophytes and rotifers. This lake had a high pH and a very high content of bound carbon dioxide. Although this alkalinity was due largely to bicarbonates, signfficant concentrations of carbonates were also present. The very high bicarbonate content, high pH and high specific conductance of Campus Lake may be conducive to a cyanophyte - rotifer community. No other correlations between physicochemical conditions and the qualitative composition of the plankton were observed. In both lakes where the alkalinity was due to carbonates and bicarbonates, the phytoplankton and zooplankton communities were significantly larger, always more than twice those of the other lakes.

All algae (Anabaena spiroides, Anabaenopsis circularis, Oscillatoria spp., Chrysosphaerella longispina, planktonic and epiphytic diatoms, Ankistrodesmus falcatus, Closterium sp., Scenedesmus spp. and Euglena spp.) which were frequent or abundant in the lakes were also present throughout the year. Their physicochemical tolerances were, therefore, well within the ranges of the physicochemistry of the University Lake System.

Many algal species (Agmenellum quadriduplicatum, Anacystis cyanea, Arthrospira jenneri, Tribonema bombycinum, Actinastrum gracillimum, Chlamydomonas spp., Chlorella spp., Cladophora spp., Closterium moniliforme, Cosmarium spp., Gonium pectorale, Microspora amoena, Oedogonium spp., Pandorina morum, Pediastrum spp., Spirogyra spp. and Staurastrum sp.) occurred either less frequently in all lakes, infrequently or frequently in only one or two of the lakes, or only during one or two months. The occurrence of those species may have been less frequent or sporadic because the physicochemistry of the lakes represented either an extreme of their physicochemical tolerance range or perhaps those species were less able to compete with the other organisms. No seasonal trends or additional correlations between physicochemical conditions and the qualitative or quantitative composition of the organisms were observed.

Figure 1. Vicinity Map of University Lake System, Baton Rouge, East Baton Rouge Parish, Louisiana (modified from Odom, 1968).



CITY LIMITS
BATON ROUGE, LA.
67
37
Capitol Lake
MISSISSIPPI RIVER
INTERSTATE 10
University Lake System
LOUISIANA STATE UNIVERSITY
KANSAS CITY SOUTHERN
CITY LIMITS
30
42

Figure 2. Study Area: University Lake System, Sampling Stations (1 - 7) and Interconnections (A - F).

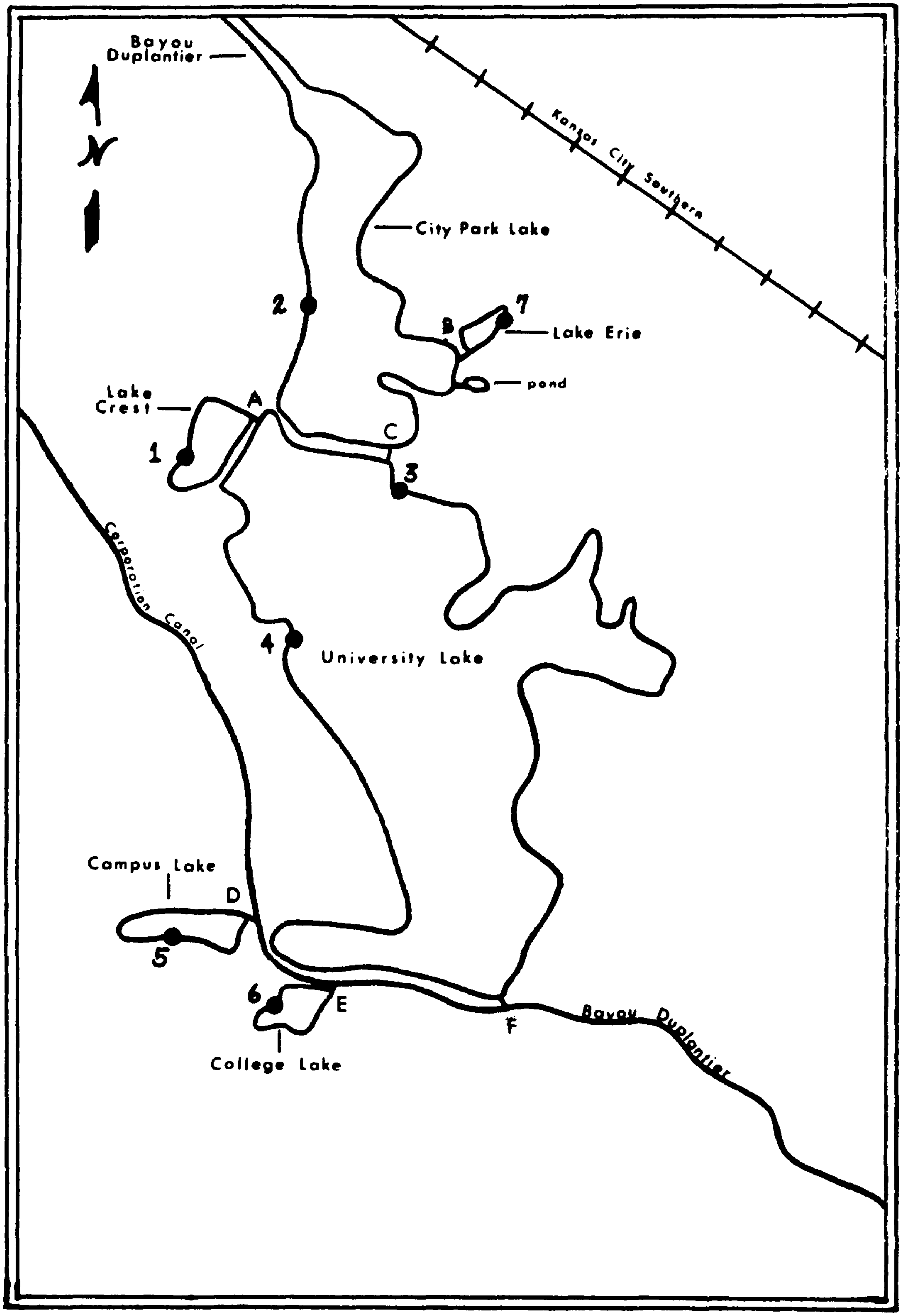
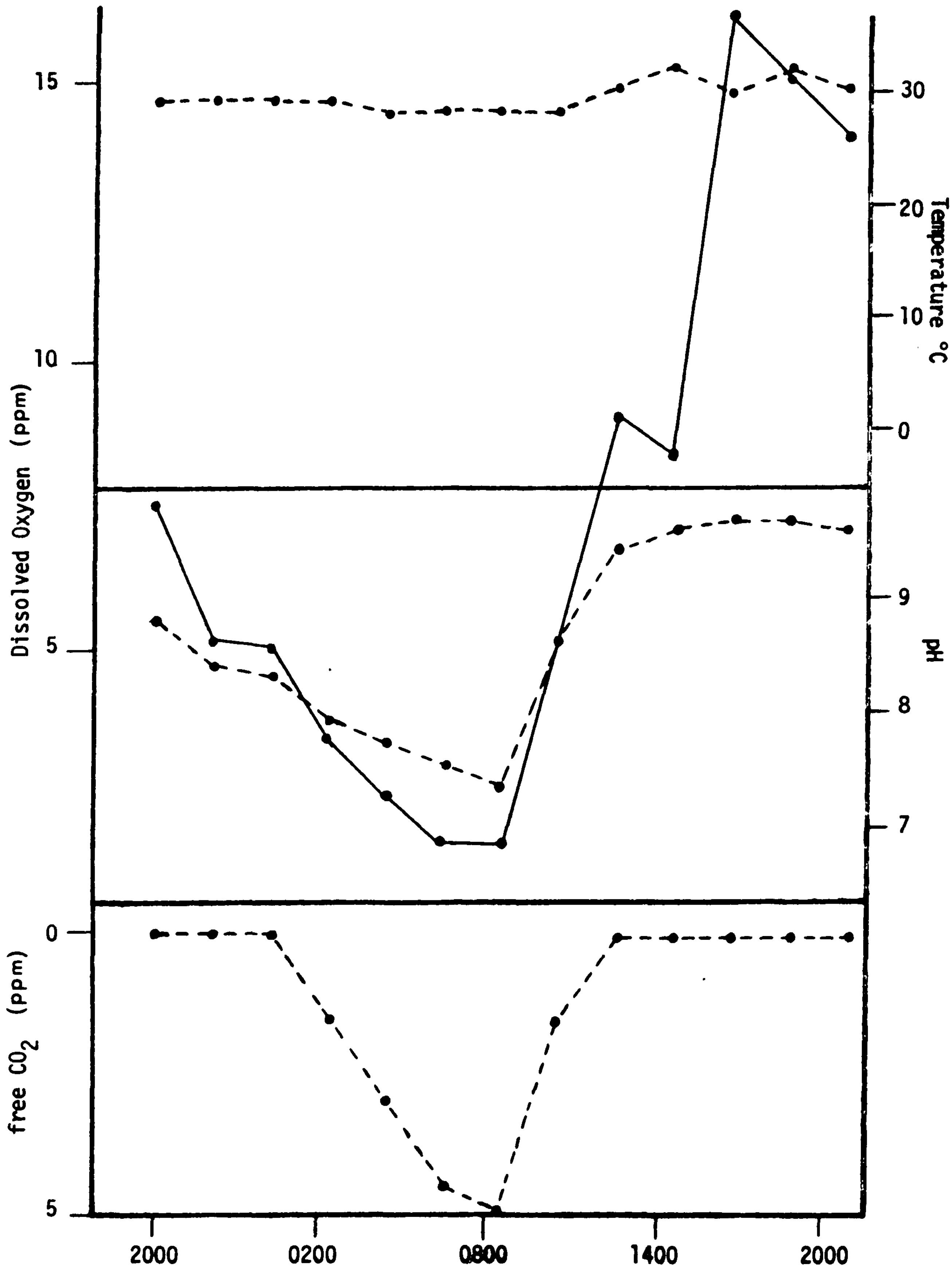
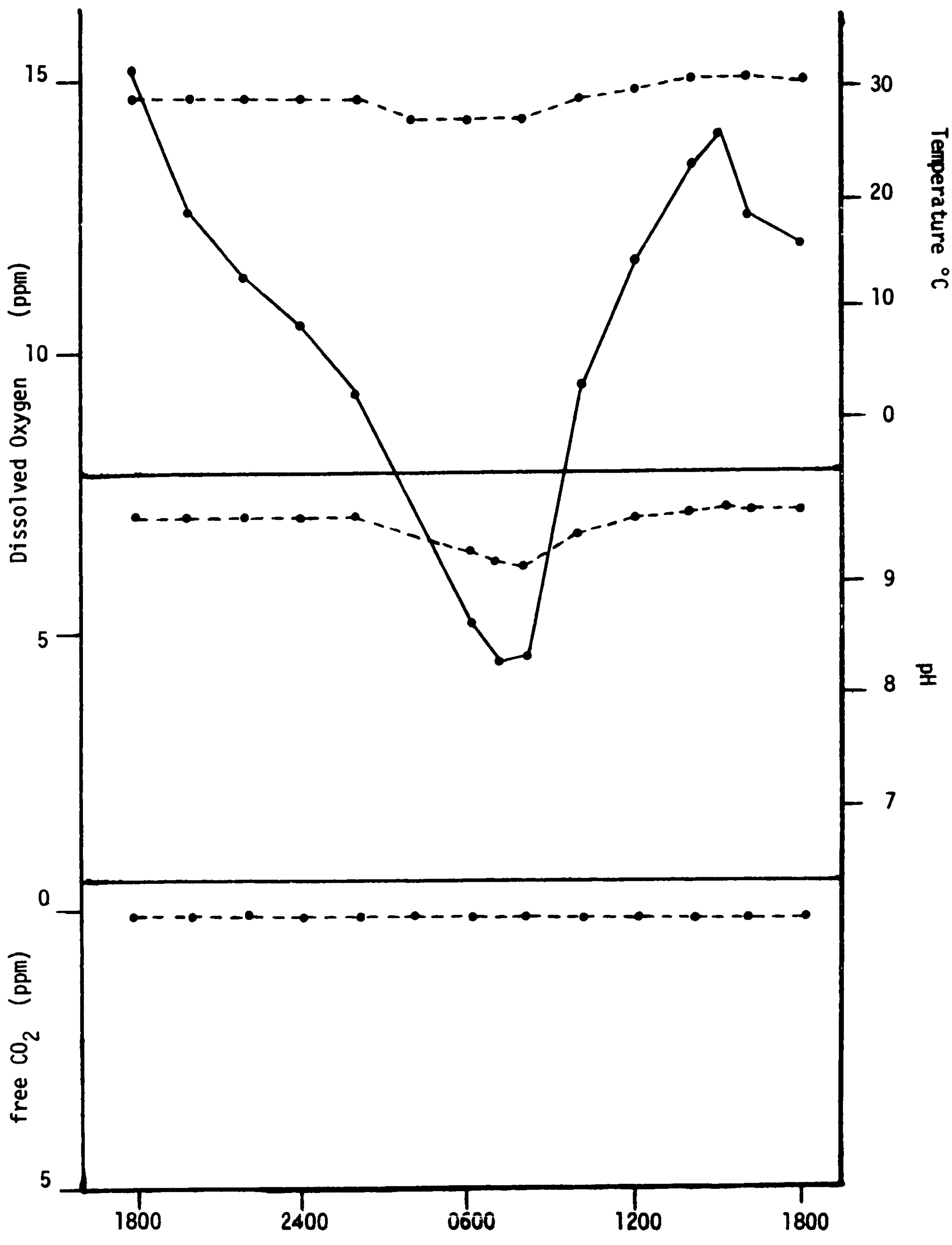

Bayou
Duplantier
N
City Park Lake
Kansas City Southern
2
7
B
Lake Erie
pond
Lake
Crest
A
1
C
3
Corporation Canal
4
University Lake
Campus Lake
D
5
6
E
F
College Lake
Bayou Duplantier

Figure 3. Diel Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 4, Summer (August 15-16, 1972) following heavy two-hour rain.



Dissolved Oxygen (ppm)
15
10
5
0
free CO_2 (ppm)
0
5
Temperature °C
30
20
10
0
pH
9
8
7
2000
0200
0800
1400
2000

Figure 4. Diel Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 4, Summer (August 30-31, 1972) following clear sunny day.



Dissolved Oxygen (ppm)
free CO_2 (ppm)
Temperature °C
pH
15
10
5
0
5
30
20
10
0
9
8
7
1800
2400
0600
1200
1800

Figure 5. Diel Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 4, Fall (November 8-9, 1972) following clear sunny day.

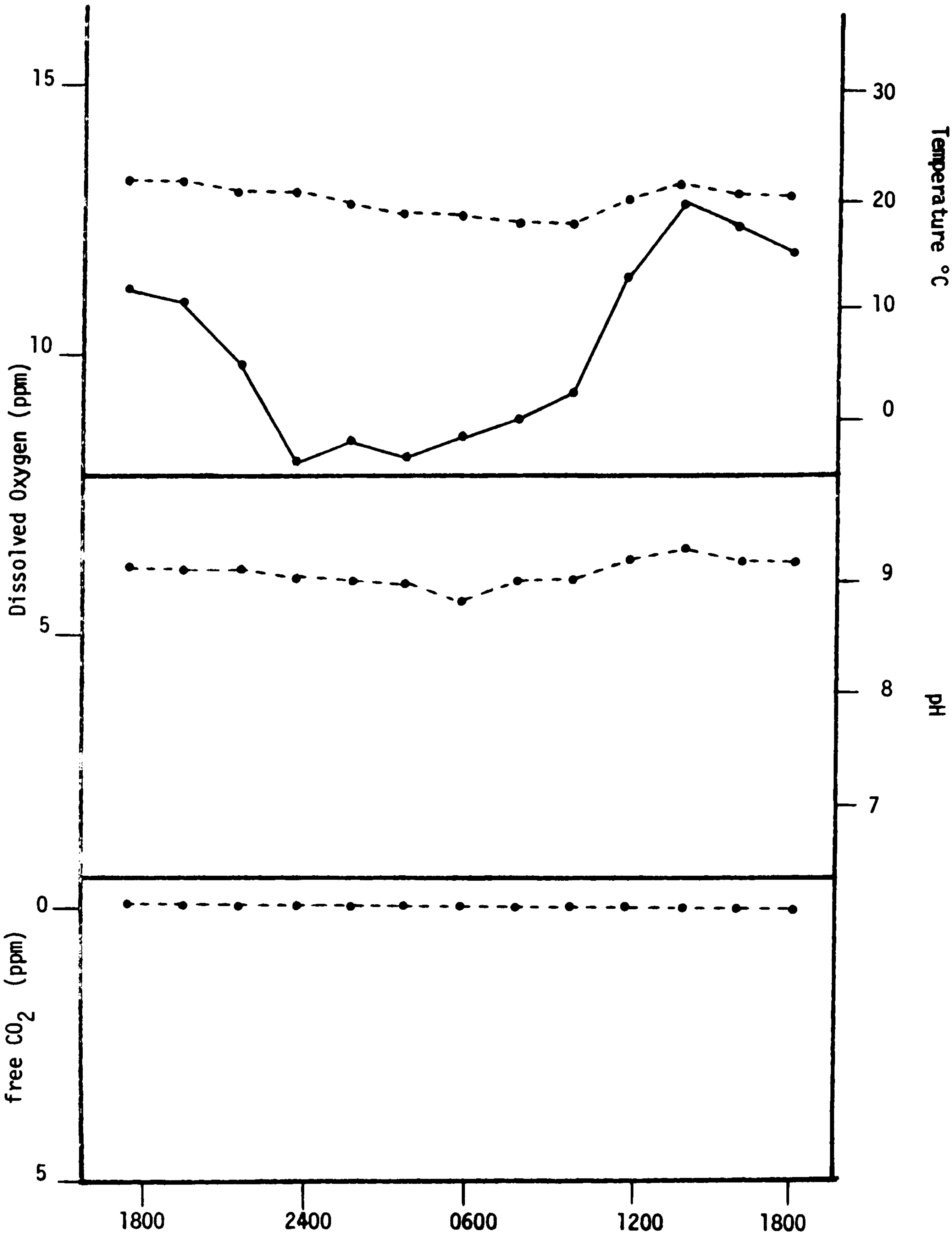
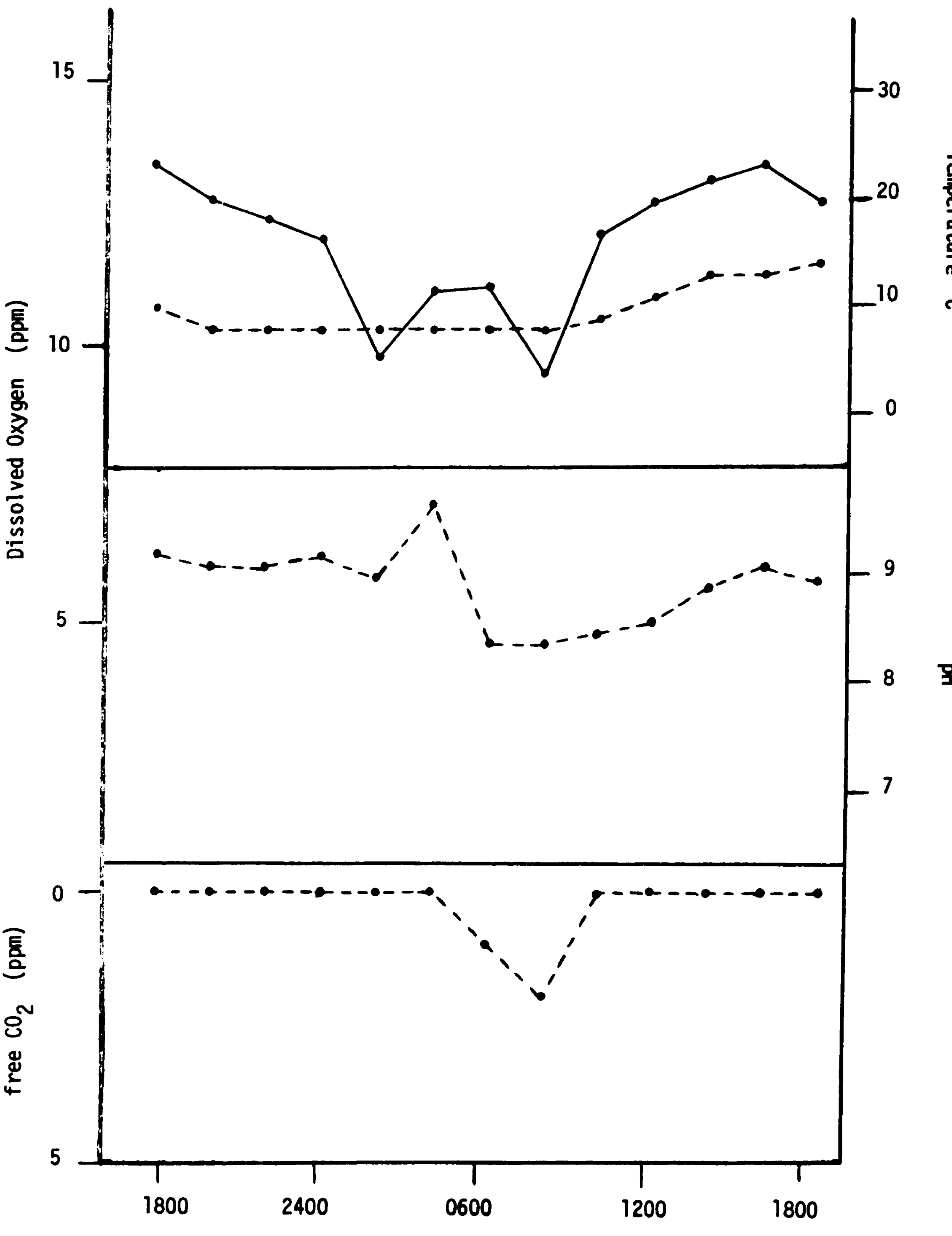
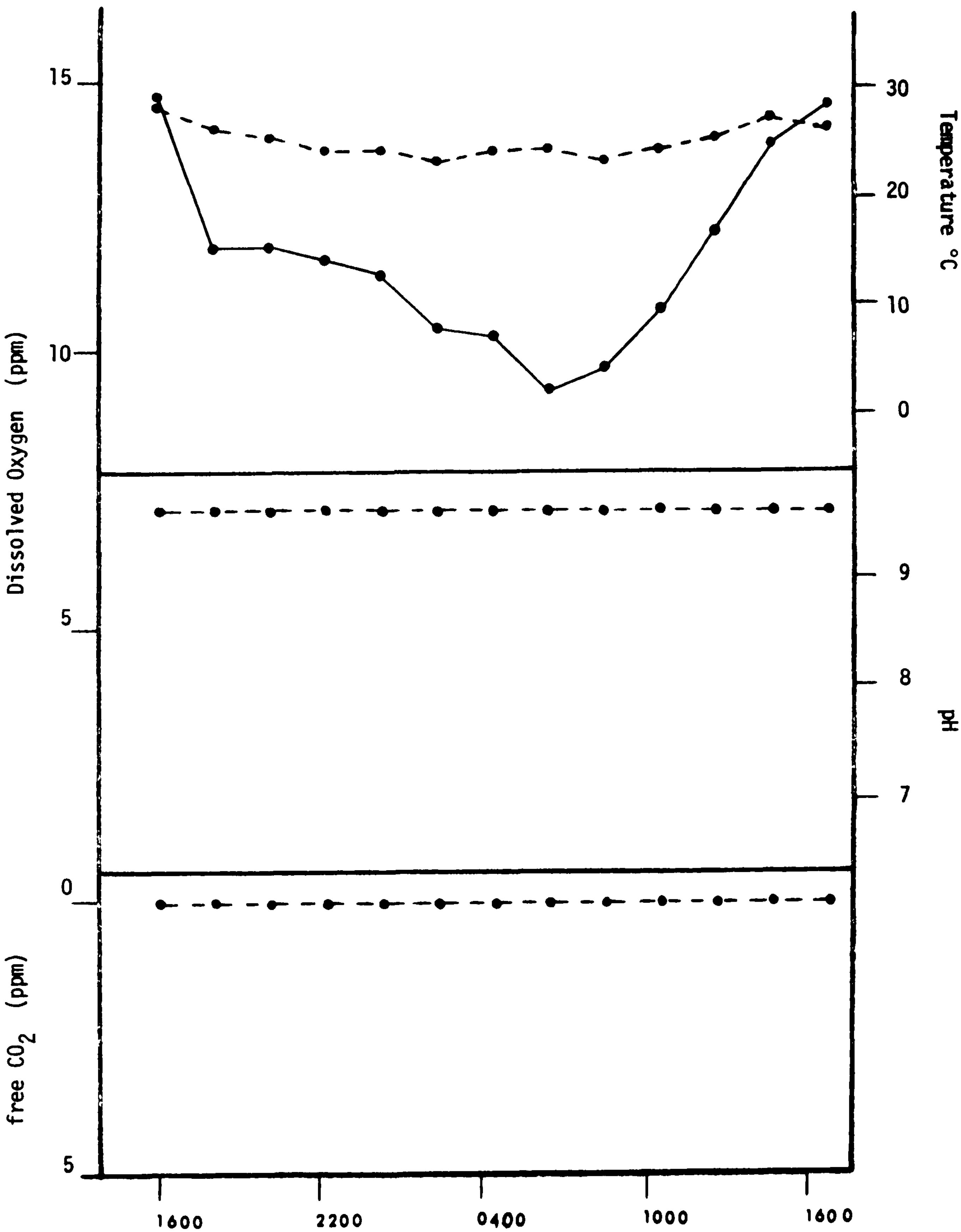

15
10
5
0
5
Dissolved Oxygen (ppm)
free CO_2 (ppm)
30
20
10
0
Temperature °C
9
8
7
pH
1800
2400
0600
1200
1800

Figure 6. Diel Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 4, Winter (February 17-18, 1973) following clear sunny day.



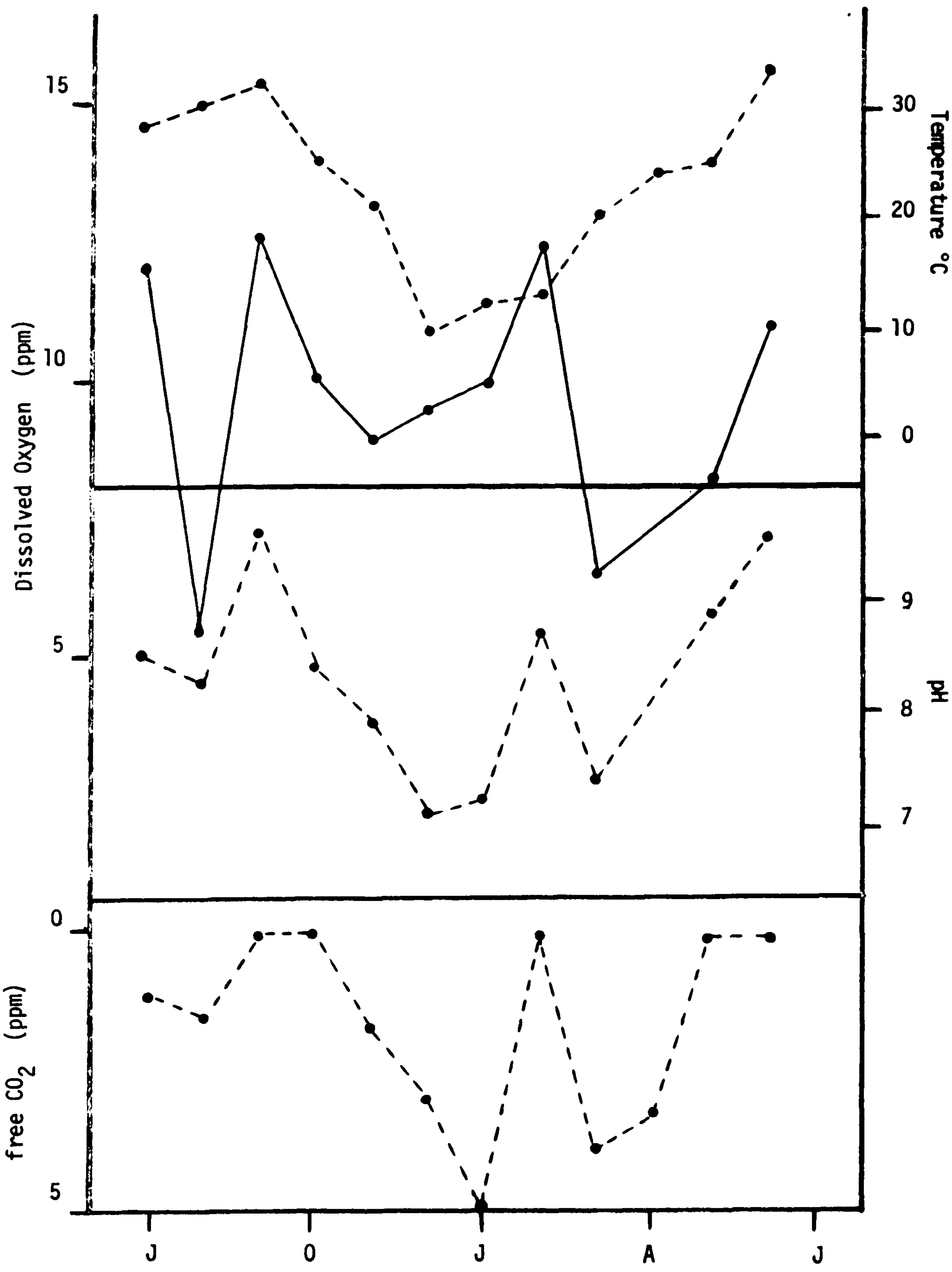
Dissolved Oxygen (ppm)
15
10
5
0
5
free CO_2 (ppm)
Temperature °C
30
20
10
0
pH
9
8
7
1800
2400
0600
1200
1800

Figure 7. Diel Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 4, Spring (May 15-16, 1973) following clear sunny day.



Dissolved Oxygen (ppm)
15
10
5
0
free CO_2 (ppm)
5
Temperature °C
30
20
10
0
pH
9
8
7
1600
2200
0400
1000
1600

Figure 8. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 1.



Dissolved Oxygen (ppm)
15
10
5
free CO_2 (ppm)
0
5
Temperature °C
30
20
10
0
pH
9
8
7
J
O
J
A
J

Figure 9. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 2.

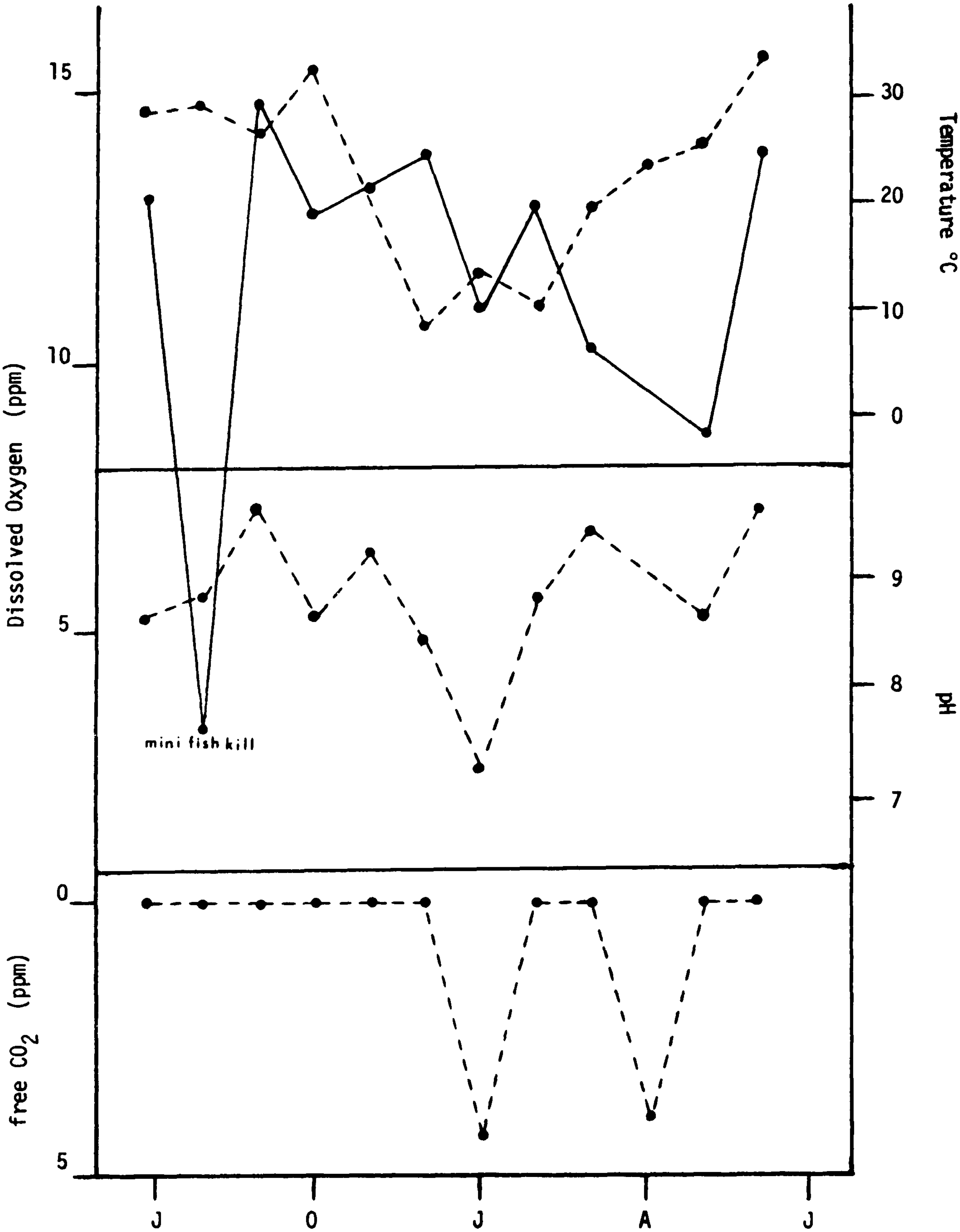

15
10
5
0
5
Dissolved Oxygen (ppm)
free CO_2 (ppm)
30
20
10
0
Temperature °C
9
8
7
pH
mini fish kill
J
O
J
A
J

Figure 10. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 3.

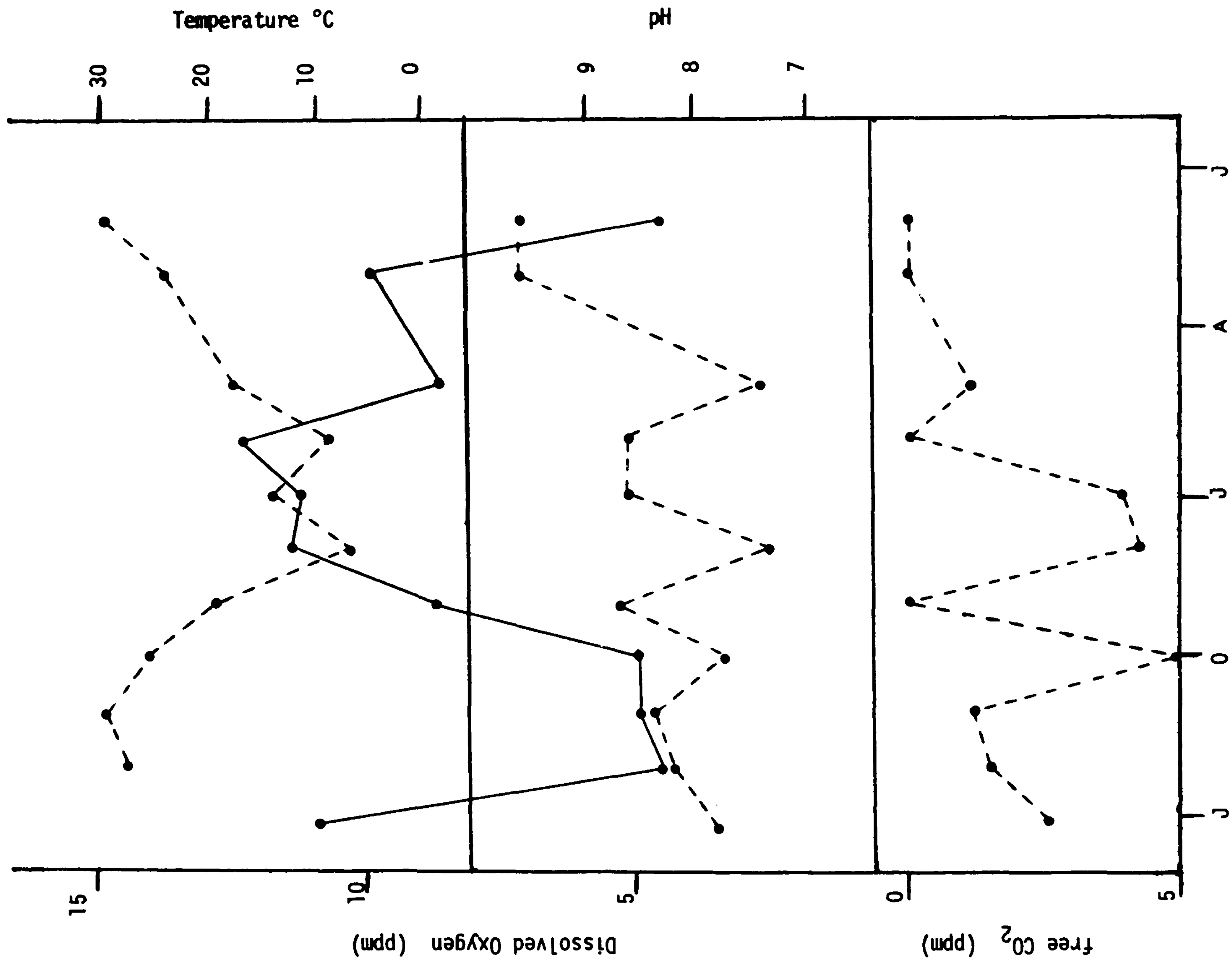
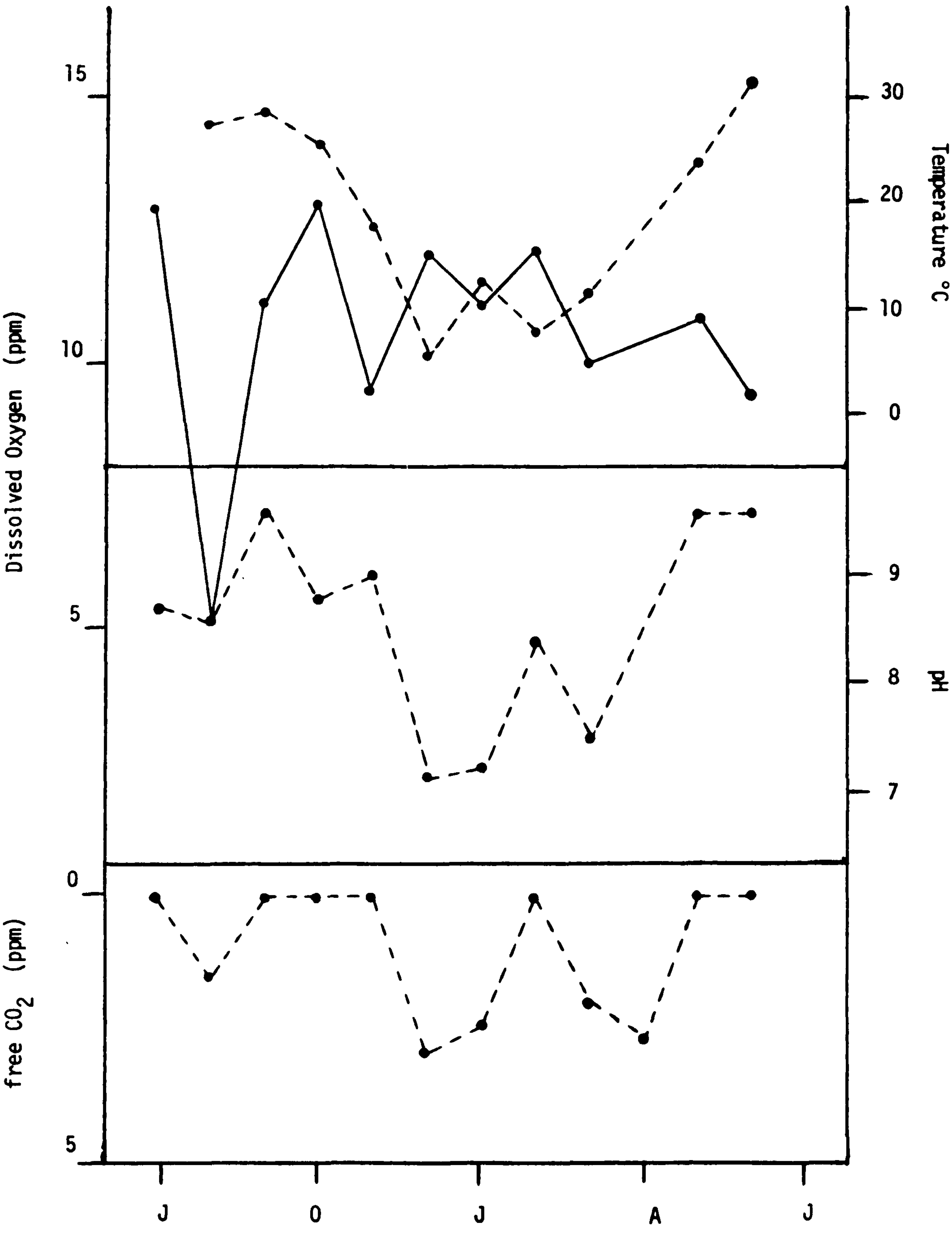

Temperature °C
pH
Dissolved Oxygen (ppm)
free CO_2 (ppm)
30
20
10
0
9
8
7
15
10
5
0
5
J
A
J
O
J

Figure 11. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 4.



Dissolved Oxygen (ppm)
free CO_2 (ppm)
Temperature °C
pH
15
10
5
0
5
30
20
10
0
9
8
7
J
O
J
A
J

Figure 12. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 5.

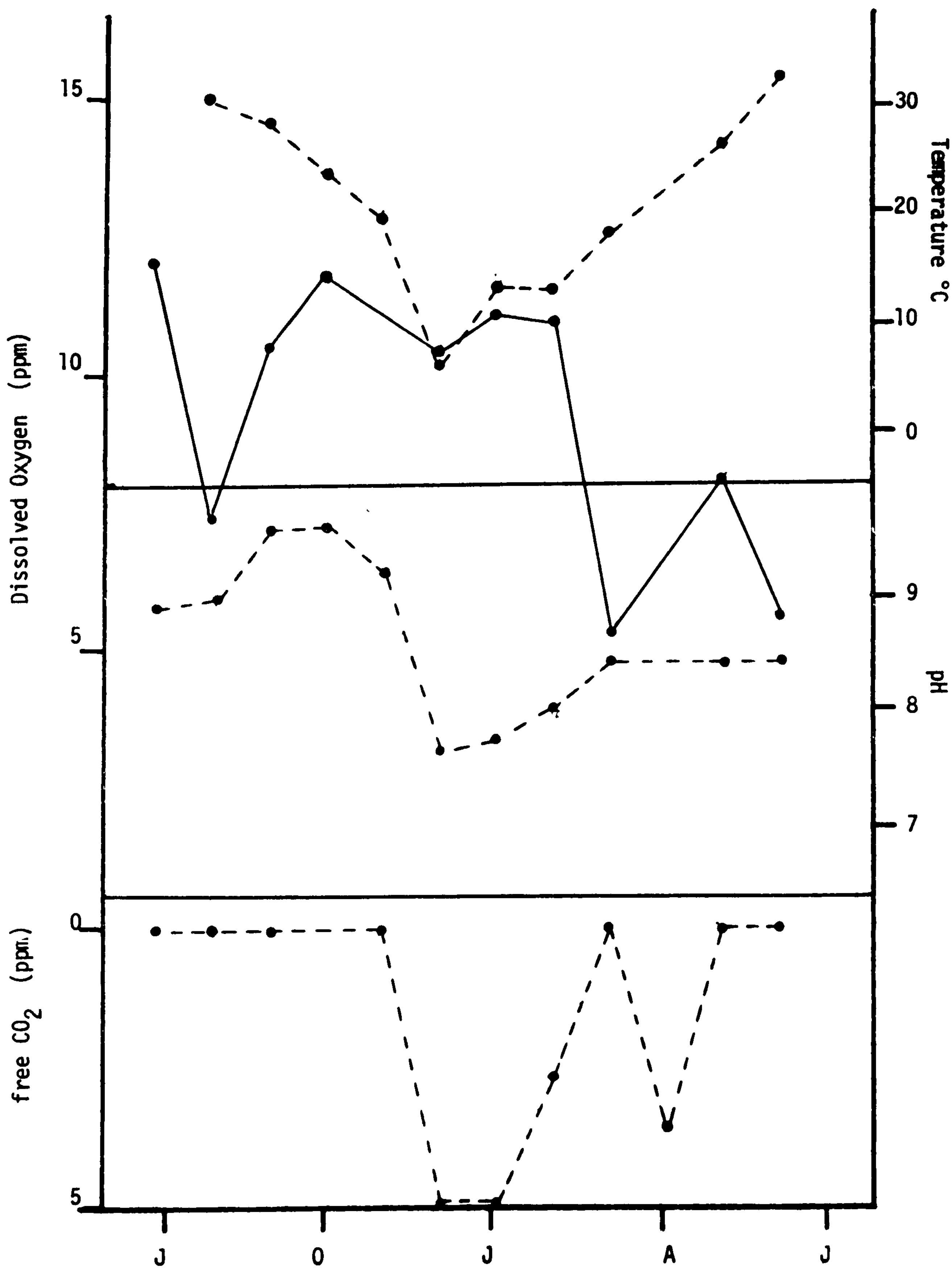
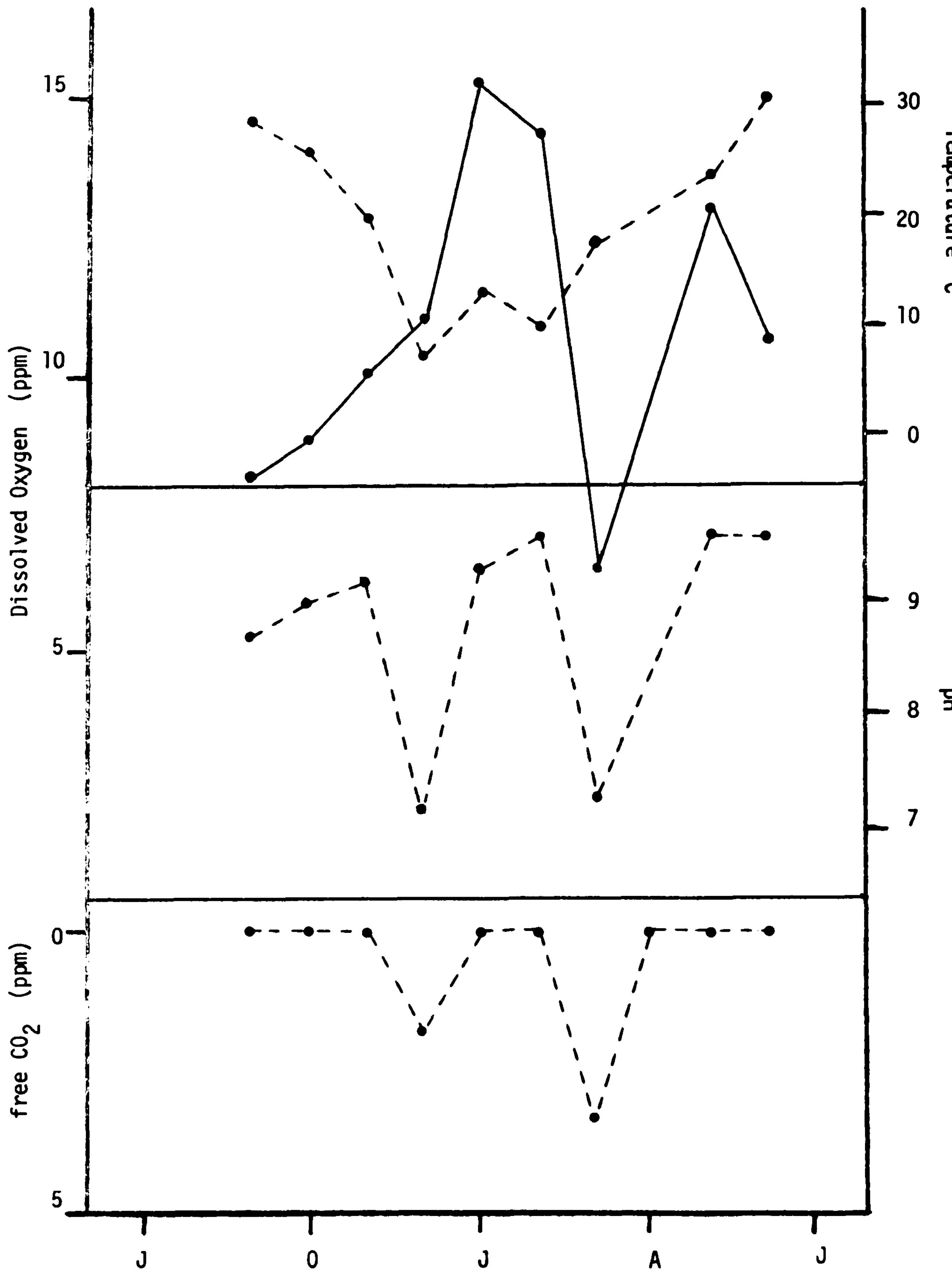
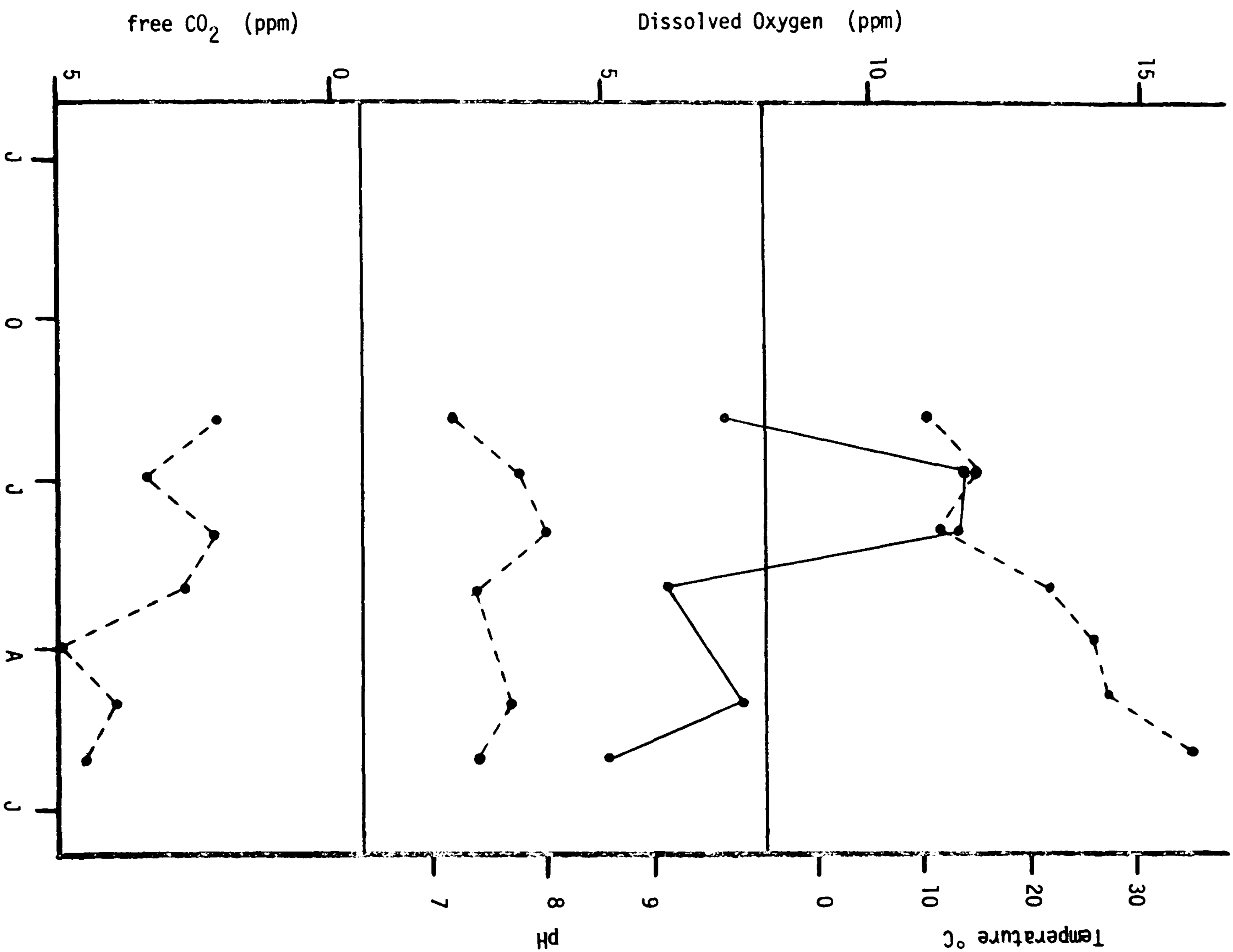

15
10
5
0
5
Dissolved Oxygen (ppm)
free CO_2 (ppm.)
30
20
10
0
Temperature °C
9
8
7
pH
J
O
J
A
J

Figure 13. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 6.



Dissolved Oxygen (ppm)
15
10
5
free CO_2 (ppm)
0
5
Temperature °C
30
20
10
0
pH
9
8
7
J
O
J
A
J

Figure 14. Annual Fluctuations in Water Temperature, Dissolved Oxygen, pH and Free Carbon Dioxide of Surface Water, Station 7.



free CO_2 (ppm)
Dissolved Oxygen (ppm)
5
0
5
10
15
J
O
J
A
J
7
8
9
0
10
20
30
pH
Temperature °C

Figure 15. Diel Fluctuations in Total Alkalinity, Methyl Orange and Phenolhthalein Alkalinities of Surface Water, Station 4:

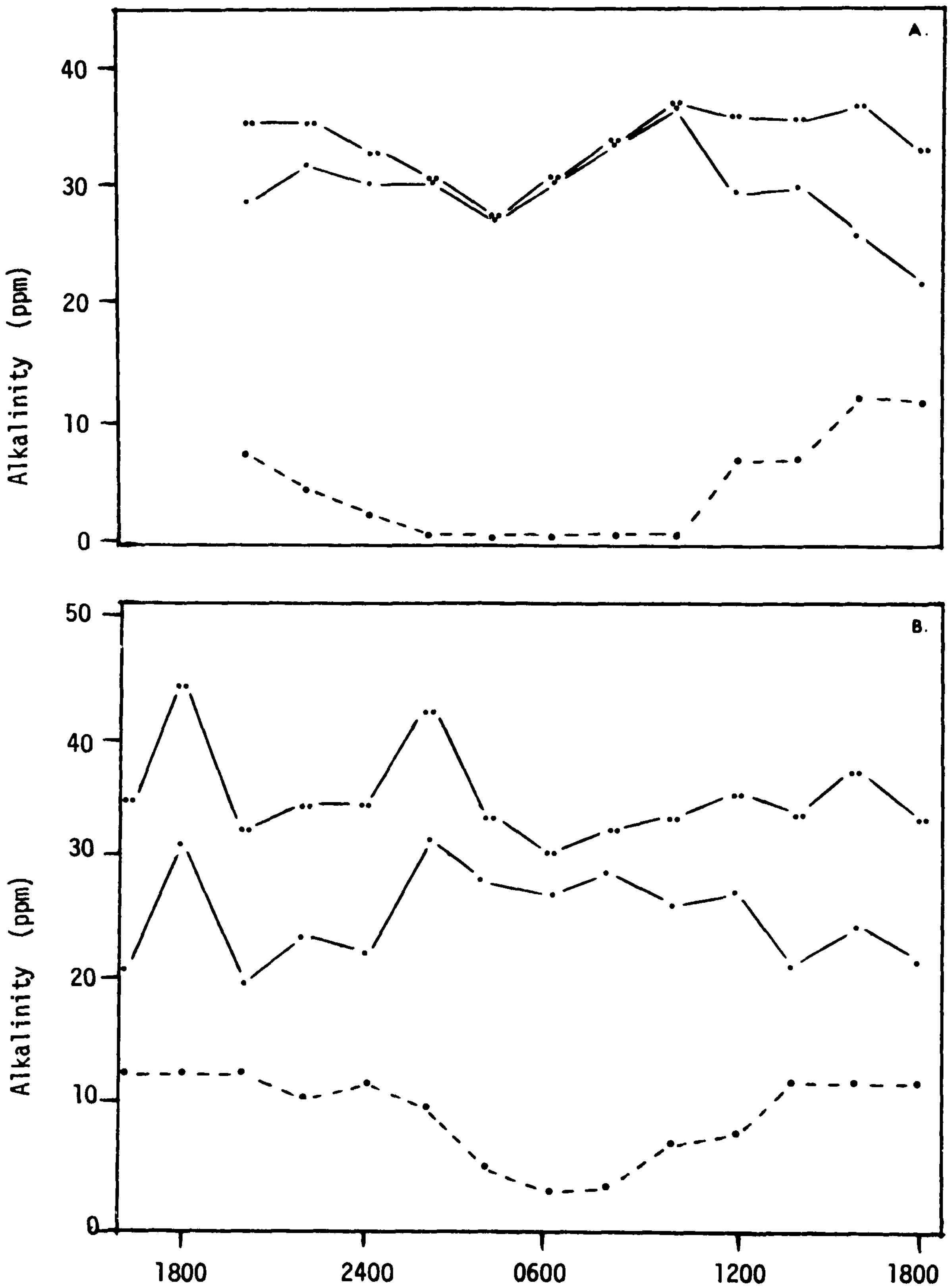
A. Summer (August 15-16, 1972) following heavy two-hour rain.

B. Summer (August 30-31, 1972) following clear sunny day.

Legend. Methyl Orange Alkalinity •——•

Phenolhthalein Alkalinity •- - - •

Total Alkalinity ••——••



A.
B.
Alkalinity (ppm)
Alkalinity (ppm)
0
10
20
30
40
50
1800
2400
0600
1200
1800

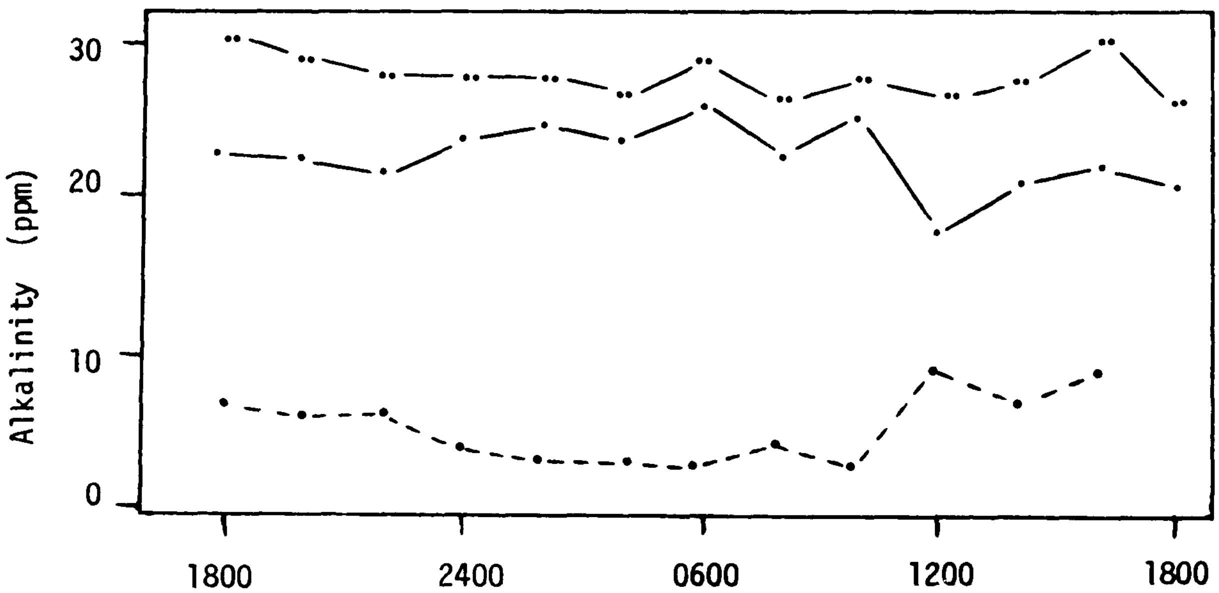


Figure 16. Diel Fluctuations in Total Alkalinity, Methyl Orange and Phenolphthalein Alkalinities of Surface Water, Station 4, Fall (November 8-9, 1972) following clear sunny day.

Legend. Methyl Orange

Phenolphthalein

Total

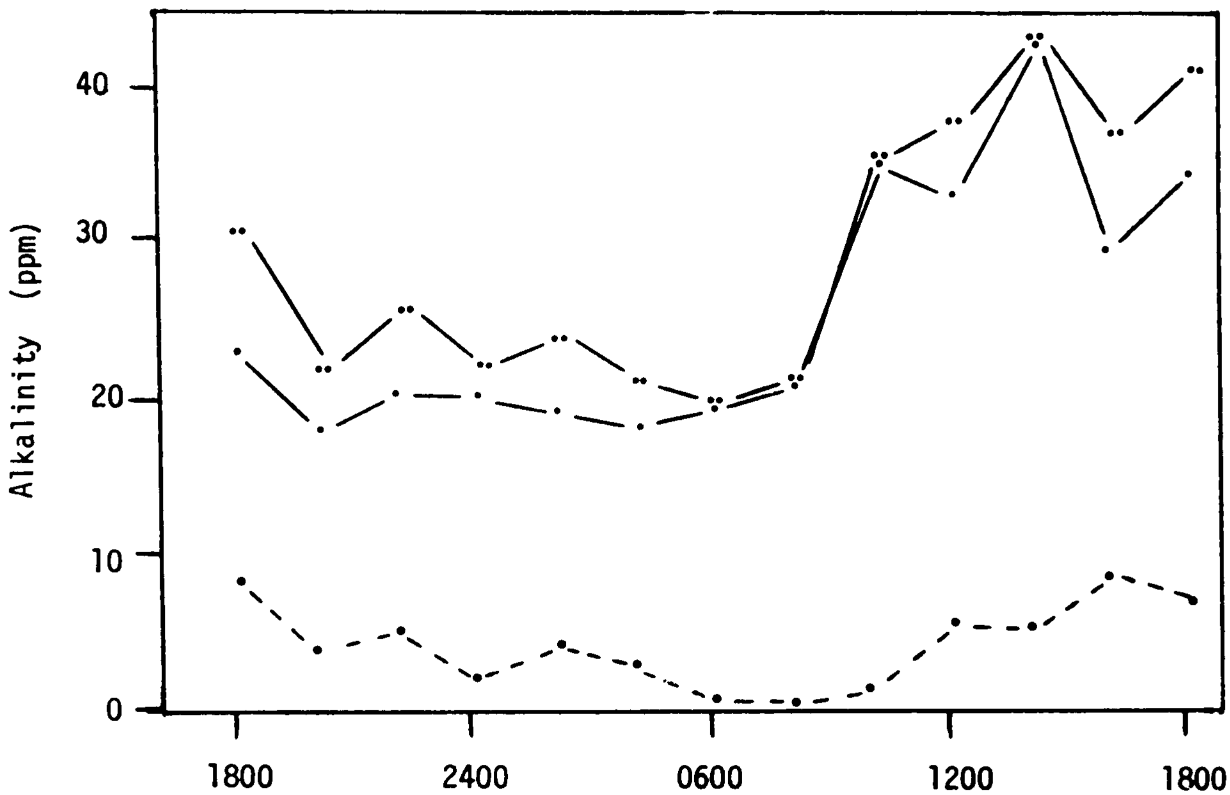


Figure 17. Diel Fluctuations in Total Alkalinity, Methyl Orange and Phenolphthalein Alkalinities of Surface Water, Station 4, Winter (February 17-18, 1973) following clear sunny day.

Legend. ••——•• Methyl Orange

•----• Phenolphthalein

••——•• Total

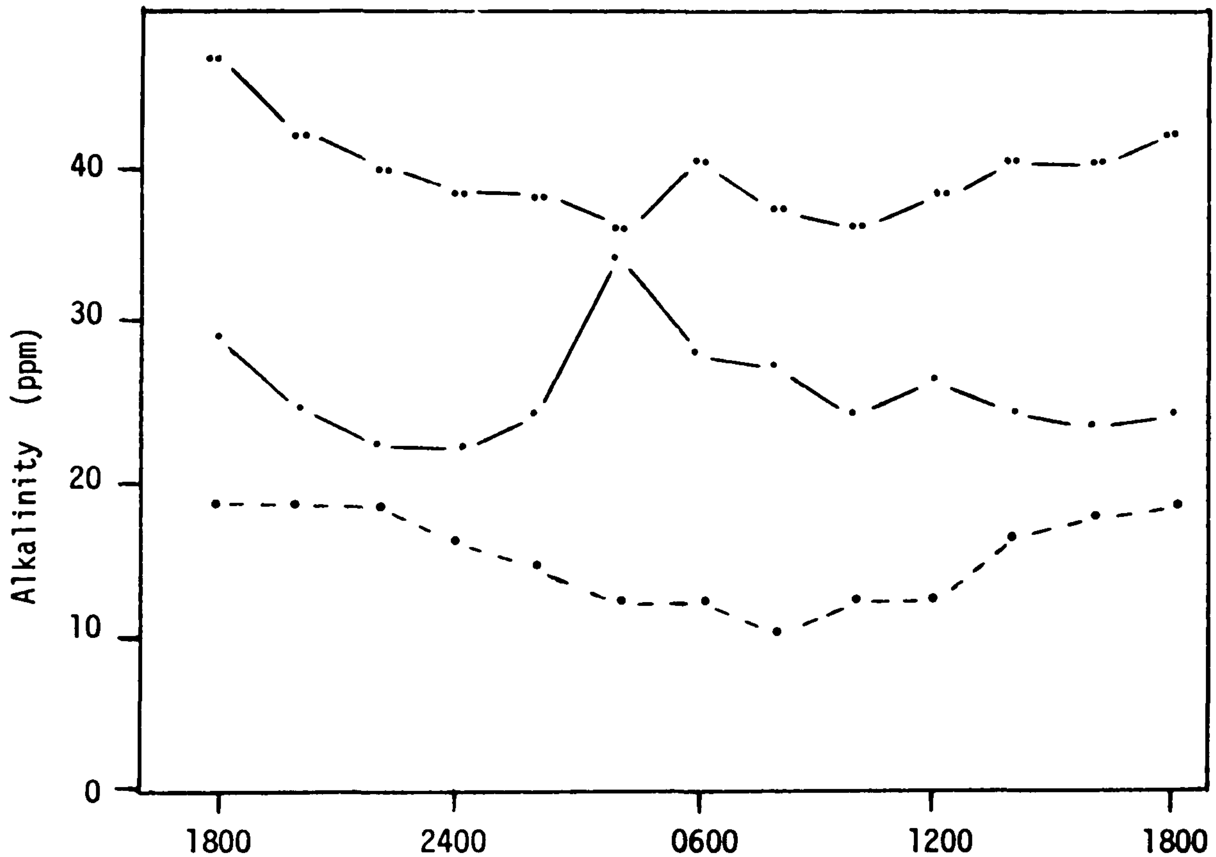


Figure 18. Diel Fluctuations in Total Alkalinity, Methyl Orange and Phenolphthalein Alkalinities of Surface Water, Station 4, Spring (May 15-16, 1973) following clear sunny day.

Legend.

·· ——— ·· Methyl Orange

• - - - - • Phenolphthalein

·· ——— ·· Total

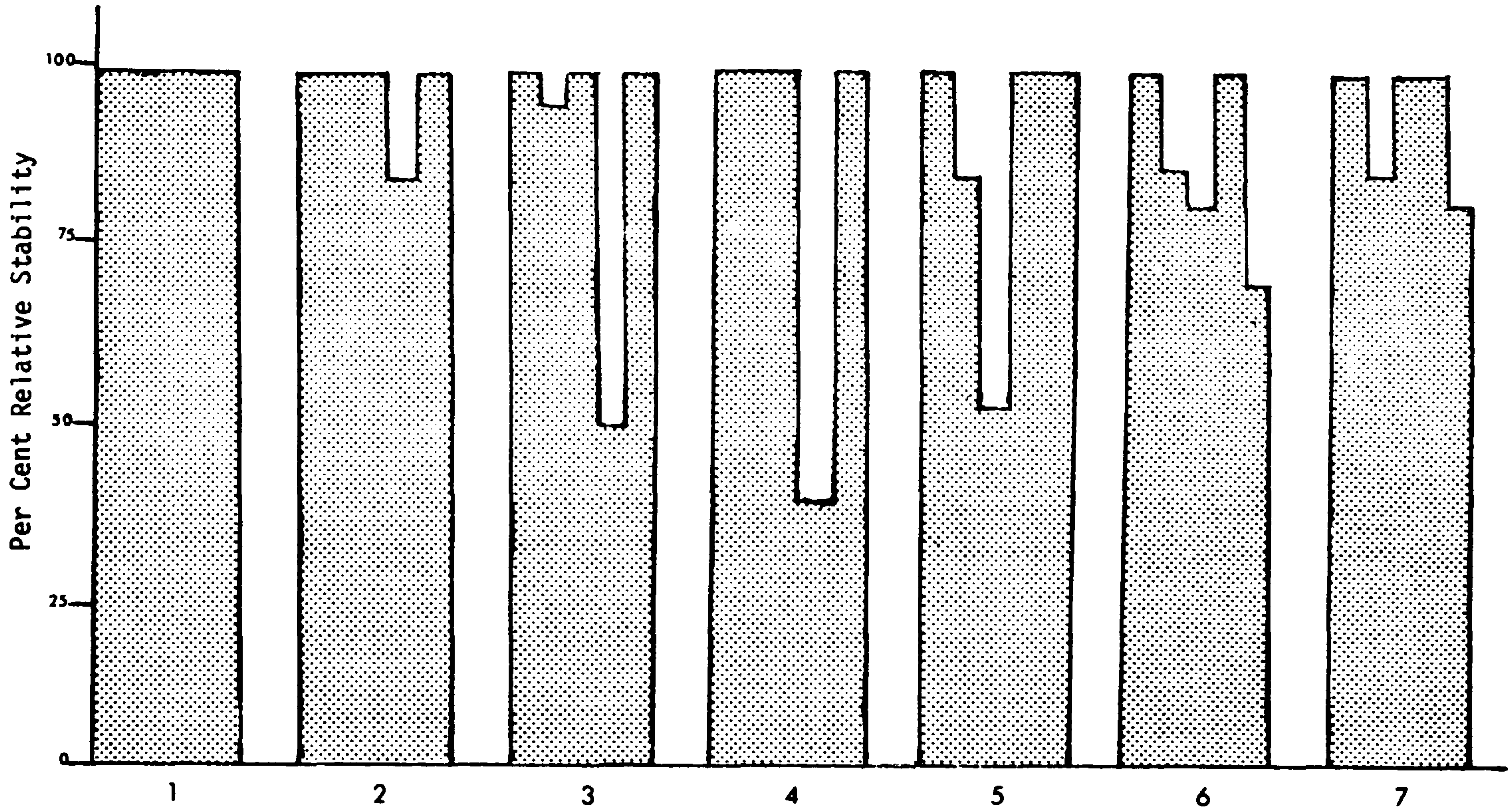


Figure 19. Relative Stability at Stations 1-7 (January, 1973 - June, 1973).

TABLE I

Ranges of physicochemical parameters

	Interconnected Lakes	Campus Lake	College Lake
Water Temp. (°C)	6 - 32	6 - 30	8 - 29
pH	7.1 - 9.6$^+$	7.6 - 9.6$^+$	7.1 - 9.6$^+$
D.O. (ppm)	3.2 - 14.8	5.3 - 12.0	6.6 - 15.7
fCO_2 (ppm)	0 - 6.6	0 - 7.0	0 - 3.4
P.A. (ppm)	0 - 12	0 - 25	0 - 17
M.O. (ppm)	15 - 64	48 -287	5 - 51
T.A. (ppm)	18 - 69	48 -304	12 - 51
Ca. Hard. (ppm)	34 - 68	17 - 51	34 - 34
Mg. Hard. (ppm)	0 -120	17 - 86	17 -103
Total Hard. (ppm)	51 -171	68 -103	51 -137
Spec. Cond. (micromhos/cm)	70 -195	157 -450	47 -180
Chloride (ppm)	6.0 - 32.0	5.5 - 17.0	7.0 - 13.0
ortho-PO_4 (ppm)	0.02 - 4.00	0.08 - 2.80	0.13 - 1.50
NH_3-N (ppm)	0.25 - 1.85	0 - 1.00	0.35 - 1.03
NO_3-N (ppm)	0 - 0.35	0 - 0.89	0 - 0.13
H_2S (ppm)	0 - 0.12	0.02 - 0.07	0.07 - 0.22
Copper (ppm)	0.01$^-$- 0.50	0.01$^-$- 0.30	0.01$^-$- 0.70
Iron (ppm)	0.2 - 1.1	0.2 - 0.9	0.8 - 1.3
Apparent Color (PCU)	70 -265	15 -225	175 -450
Turbidity (JTU)	10 - 75	0 - 59	45 -140
% Transmittance	80 -100	85 -100	71 - 90
Secchi Trans. (inches)	9 - 18	9 - 20	9 - 10

The lakes have no littoral zone, are very shallow (less than 6 ft. deep), range in size from 3.0 to 188.1 acres, and have silt deposits 1 to 2 feet deep in their basins.

Temporary thermal stratification was observed only in the spring and early summer in College Lake, Lake Erie and Lake Crest. These lakes had the smallest surface areas but the deepest basins. The stratification was easily upset by rains which are very common throughout the year in this area. There was, therefore, no winter stagnation period.

Lake water usually maintained dissolved oxygen saturations of 100% or greater, no free carbon dioxide and a high pH (to 9.6^{+}). Frequent rains agitated the water, and dissolved oxygen, free carbon dioxide and alkalinities were relatively uniform throughout the water column. The total hardness of the lake system was due to calcium and magnesium bicarbonates (to 171 ppm). The alkalinity was primarily due to the bicarbonate content of the waters (to 287 ppm). Specific conductance was low and reflected the amount of rainfall and total alkalinity. Phosphates and nitrates were high. Ammonia and hydrogen sulfide were low.

The watershed had a high iron content. The lakes were colored, and extremely low Secchi disk readings (to 9 in.) were common throughout the year. Turbidity was high and due to an abundance of planktonic organisms, rather than to silt. Light transmittance was correspondingly low.

Summary

The University Lake System in southeastern Louisiana is a series of six manmade, fresh-water lakes on or adjacent to the Baton Rouge campus of Louisiana State University. The lakes were impounded between 1925 and 1933 in a typical backswamp area of the Mississippi River floodplain, an area characterized by dark and peaty soils of the Recent epoch. The lakes cover about 350 acres.

Four of the lakes were originally interconnected by concrete flumes. In 1968 the interconnections were occluded, and now, although there is water overflow, a relatively closed basin has been created for each lake.

Soils from the lakes' basins contain as much as 3.7% organic matter, maintain a relatively high pH (to 7.3), and are rich in extractable nutrients such as potassium, phosphorus, calcium and magnesium.

Louisiana's long growing season has contributed to the early eutrophication of the lake system. Much surrounding vegetation affords sizable contributions of allochthonous organic matter, particularly in the peripheral regions of the lakes. Extensive leaf litter in various stages of decomposition has accumulated in the lakes' basins.

The lakes have no littoral zone, are very shallow (less than 6 ft. deep), range in size from 3.0 to 188.1 acres, and have silt deposits 1 to 2 feet deep in their basins.

Temporary thermal stratification was observed only in the spring and early summer in College Lake, Lake Erie and Lake Crest. These lakes had the smallest surface areas but the deepest basins. The stratification was easily upset by rains which are very common throughout the year in this area. There was, therefore, no winter stagnation period.

Lake water usually maintained dissolved oxygen saturations of 100% or greater, no free carbon dioxide and a high pH (to 9.6^{+}). Frequent rains agitated the water, and dissolved oxygen, free carbon dioxide and alkalinities were relatively uniform throughout the water column. The total hardness of the lake system was due to calcium and magnesium bicarbonates (to 171 ppm). The alkalinity was primarily due to the bicarbonate content of the waters (to 287 ppm). Specific conductance was low and reflected the amount of rainfall and total alkalinity. Phosphates and nitrates were high. Ammonia and hydrogen sulfide were low.

The watershed had a high iron content. The lakes were colored, and extremely low Secchi disk readings (to 9 in.) were common throughout the year. Turbidity was high and due to an abundance of planktonic organisms, rather than to silt. Light transmittance was correspondingly low.

Although the ranges of all physicochemical parameters measured were narrow, they fluctuated irregularly throughout the year. No clear-cut seasonal trends were evident from the study. Only pH, specific conductance and alkalinity showed any tendency toward seasonality. Alkalinity, specific conductance, pH and temperature usually decreased simultaneously. Because these parameters are functions of each other, any change in one was expected in the others.

Seasonal diel studies of pH, dissolved oxygen, free carbon dioxide and alkalinities, and monthly determinations of primary productivity (light and dark bottle method) suggested an accelerated community metabolism and the presence of a large and active phytoplankton community. Primary productivity in the University Lake System was primarily a function of the phytoplankton communities rather than the filamentous algae and tracheophytes.

Relative stability tests suggested that the lakes were stable and that they had high biochemical oxygen demands, but were capable of meeting those demands. Those tests also suggested that domestic wastes emptying into the lakes from homes in the area were only evident during periods of increasingly heavy rainfall.

Thirty-five species of algae, 37 species of vascular plants, 76 species of invertebrates and 16 species of fishes are reported. With the few exceptions listed below, all organisms reported in this study are not uncommon in similar habitats throughout Louisiana.

Predominant plankton included various cyanophytes, chlorophytes, rotifers, copepods, nauplius larvae and bryozoan floatoblasts. The predominant emergent and floating vascular plants were Colocasia antiquorum and Eichhornia crassipes, respectively. The most common benthos were the filamentous chlorophytes, the ectoproct Plumatella repens, various leeches, the damselfly nymph Ischnura, tendipedid larvae, the crustaceans Hyalella azteca and Palaemonetes kadiakensis and various gastropods. The most abundant small fish was Gambusia affinis, and the most common game fishes were centrarchids and ictalurids.

Two leeches, Helobdella fusca and H. stagnalis, are reported new to Louisiana. This report extends their known distribution several hundred miles. A leech tentatively identified as Dina parva may also be a first report for Louisiana. An ectoproct believed to be Hyalinella punctata is not previously reported from the state. The coleopteran Peltodytes and the odonate nymph Brechmorrhoga mendax are uncommon in southern Louisiana. Brechmorrhoga mendax is also a possible state record.

The four interconnected lakes had similar physicochemical features. College Lake had physicochemical features similar to those of the interconnected lakes. Campus Lake, however, maintained a considerably higher bicarbonate alkalinity (to 304 ppm) and a correspondingly higher specific conductance (to 450 micromhos/cm).

The biota were relatively similar in all of the lakes. The plankton showed the only significant qualitative and quantitative variations. The plankton in the interconnected lakes consisted primarily of cyanophytes, chlorophytes, rotifers, copepods and nauplius larvae. No single group predominated the plankton of those lakes. Plankton in College Lake consisted mainly of cyanophytes, copepods and nauplius larvae. Plankton in Campus Lake was composed primarily of cyanophytes and rotifers. Both phytoplankton and zooplankton were far more abundant in College Lake and Campus Lake than in the interconnected lakes. The high bicarbonate content and high specific conductance of Campus Lake may be conducive to a cyanophyte-rotifer community.

All lakes are autotrophic ecosystems whose large phytoplankton communities base a food chain supporting optimal fish communities comparable to those of other Louisiana lakes of similar size.

Baseline studies of this type are wanting on the fresh and brackish waters of Louisiana. This study suggests that many classical physicochemical trends characteristic of lakes with thermal stratification are less applicable in the limnology of certain southern lakes. Reference points for this area must now be established, and more ecological studies must be made. Further studies may result in the realization of the ubiquitous nature of many organisms now believed to be restricted to more northern areas.

Literature Cited

American Public Health Association. 1955. Standard Methods for Examination of Water and Waste Water. Amer. Publ. Health Assn., Washington, D. C. 522p.

________. 1971. Standard Methods for Examination of Water and Waste Water. 13th ed. Amer. Publ. Health Assn., Washington, D.C. 874p.

Bamforth, S. S. 1963. Limnetic protozoa of southeastern Louisiana. Proc. La. Acad. Sci. 26: 120-134.

Beerman, H. 1924. Some physiological actions of hydrogen sulfide. J. Exp. Zool. 41: 33-43.

Bick, G. H. 1957. The donata of Louisiana. Tulane Studies in Zoology, 5: 71-135.

Braidech, M. M. and F. H. Emery. 1935. The spectrographic determination of minor chemical constituents in various water supplies in the United States. J. Amer. Wat. Wks. Assn. 27: 557-580.

Brown, C. A. 1943. Vegetation and lake level correlations at Catahoula Lake, Louisiana. Geograph. Rev. 33: 435-445.

________. 1972. Wildflowers of Louisiana and Adjoining States. La. State Univ. Press. Baton Rouge, 241p.

Brown, H. J. 1930. The Desmids of the southeastern coastal plain region of the United States. Trans. Amer. Microsc. Soc. 49: 86-104.

Brupbacher, R. H., W. P. Bonner and J. E. Sedberry, Jr. 1968. Analytical methods and procedures used in the soil testing laboratory. La. Agr. Exp. Sta. Bull. #632.

Buckley, B. R. 1958. The Limnology of upper Cane River Lake, Natchitoches Parish, Louisiana, with particular reference to the emergence of Tendipedidae. M.S. Thesis, Northwestern State University, Natchitoches. 45p.

Cali, F., Jr. 1972. The Ecology of a Brackish-Water Pond System in Southeastern Louisiana. M.S. Thesis, Louisiana State University in New Orleans. 87p.

Carver, D. C. 1971. Bundicks Lake (Beauregard Parish). Louisiana Wild Life and Fisheries Commission, Capitol Station, Baton Rouge, Louisiana 70804.

Cass, J. S. and P. E. Folder. 1957. Interim report on chromium: Physiologic aspects of water quality criteria with regard to man. Kettering Laboratory, Cincinnati, Ohio.

Cocke, E. G. 1967. The Myxophyceae of North Carolina. Edwards Brothers, Inc. Ann Arbor, Michigan. 206p.

Correll, D. S. and H. B. Correll, 1972. Aquatic and Wetland Plants of Southwestern United States. Environmental Protection Agency. Water Pollution Control Research Series 16030 DNL. U.S. Gov. Print. Office, Washington, D.C.

Cox, Glen. 1940. A summary of hydrologic data, Bayou Duplantier watershed, 1933-1939. University Bull., La. St. Univ. & A & M. College. 32(7): 1-37.

Curry, M. G. and C. M. Allen. 1973. Alismataceae of Louisiana: Taxonomy, Distribution and Field Key. Proc. La. Acad. Sci. (in press).

Dendy, J. S. 1963. Observations on bryozoan ecology in farm ponds. Limnol. and Ocean. 8: 478-482.

Eddy, Samuel. 1957. How to Know the Freshwater Fishes. Wm. C. Brown Co., Dubuque, Iowa. 253p.

Eggler, W. A. and W. G. Moore. 1961. The vegetation of Lake Chicot, Louisiana, after eighteen-years impoundment. Southwestern Naturalist 6(3-4): 175-183.

Eriksen, C. H. 1966. Diurnal limnology of two highly turbid puddles. Verh. Internal. Verein. Limnol. 16: 507-514.

Everitt, B. C. 1972. The Distribution and Ecology of Freshwater Bryozoa of the New Orleans (Louisiana) Area. M.S. Thesis, Louisiana State University in New Orleans. 70p.

Fassett, N. C. 1969. A Manual of Aquatic Plants. Univ. of Wisconsin Press, Madison. 405p.

Featherman, V. 1871. Second Annual Botanical Survey. Annual Report: Board of Supervisors, Louisiana Legislative Documents.

__________. 1872. Third Annual Botanical Survey. Annual Report: Board of Supervisors, Louisiana Legislative Documents.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed. American Book Co., New York. 1632p.

Fisher, Jon. January 2, 1972. City Park and University Lakes A year-round recreational area. Sunday Advocate, Baton Rouge, Louisiana.

Flint, L. H. 1946. Some fresh-water red algae in Louisiana. Amer. J. Bot. 33 Suppl. 20s-21s.

Fuss, C. M. 1959. A Limnological Reconnaissance of Three Louisiana Lakes. M.S. Thesis, Univ. Southwestern Louisiana, Lafayette. 46p.

Gaarder, T. and H. H. Gran. 1927. Investigations of the production of plankton in the Oslo Fjord. Cons. Int. Explor. Mer., Rapp. et proc. Verg. 42: 3-48.

Gallagher, J. J. 1966. Rotifers new to Louisiana. Proc. La. Acad. Sci. 29: 59-63.

Geagan, D. W. and T. D. Allen. 1960. An Ecological Survey of Factors Affecting Fish Production in Louisiana Waters. Dingell-Johnson Project F-6-R Louisiana. Louisiana Wild Life and Fisheries Commission, Fisheries Section, Baton Rouge. 100p.

Geagan, D. W. and C. M. Fuss. 1959. Thermal and chemical stratification of some Louisiana lakes. Proc. La. Acad. Sci. 22: 32-43.

Goldman, C. R. 1960. Molybdenum as a factor limiting primary production in Castle Lake, California. Science 132: 1016-1017.

Gowanloch, J. N. 1945. Lovely Lake Chicot is setting for important researches. La. Conservationist 3: 5-8.

Hach Chemical Company. 1967. Hach DR Colorimeter Methods Manual. 6th ed. Hach Chemical Co., Ames. Iowa. 138p.

Hansen, K. L., E. G. Ruby and R. L. Thompson. 1971. Trophic relationships in the water hyacinth community. Quart. J. Fla. Acad. Sci. 34(2): 107-113.

Harman, W. J. 1962. A fresh water nemertine from Louisiana. Proc. La. Acad. Sci. 25: 32-34.

______. 1965. A new species of the genus Pristina (Oligochaeta: Naididae) from Louisiana. Proc. La. Acad. Sci. 28: 28-31.

Harris, B. B., and J. K. G. Silvey. 1940. Limnological Investigation on Texas Reservoir Lakes. Ecol. Mon. 10: 111-143.

Hart, W. B., P. Doudoroff and J. Greenbank. 1945. Evolution of toxicity of industrial waste, chemicals, and other substances to fresh-water fishes. Water Control Lab. Atlantic Refining Co., Philadelphia, Pa.

Hughes, J. S. 1971. D'Arbonne Lake (Union and Lincoln Parishes). Louisiana Wild Life and Fisheries Commission, Capitol Station, Baton Rouge, Louisiana 70804.

Hutchinson, G. E. 1944. Limnological studies in Connecticut. VII. A critical examination of the supposed relationships between phytoplankton periodicity and chemical changes in lake waters. Ecology 25: 3-26.

_________. 1957. A Treatise on Limnology. vol. I. Geography, Physics and Chemistry. John Wiley & Sons, Inc., New York. 1015p.

_________. 1967. A Treatise on Limnology. vol. II. Introduction to Lake Biology and the Limnoplankton, John Wiley & Sons, Inc., New York. 1115p.

Hynes, H. B. N. 1971. The Biology of Polluted Waters. Liverpool Univ. Press, Liverpool. 202p.

Jahn, F. L. 1949. How to Know the Protozoa. Wm. C. Brown Co., Dubuque, Iowa. 234p.

Jones, W. H. 1958. Cladocera of Louisiana. Proc. La. Acad. Sci. 21: 50-55.

Katz, E. E. 1967. Effects of the Chemical Eradication of Water Hyacinths on Associated Aquatic Fauna. M.S. Thesis, Stetson University, DeLand Florida.

Keeton, D. 1959. Limnological effects of introducing oil field brine into farm ponds to reduce the turbidity. Okla. Fish. Res. Lab., Rep. 72. 47p.

King, D. L. 1971. Sampling in Natural Waters. In: L. L. Ciaccio, ed.; Water and Water Pollution Handbook. vol. 2. GTE Laboratories, Inc., Marcel Dekker, Inc., New York.

Klein, L. 1959. River Pollution, 2 vols. Butterworth, Inc., Washington, D. C.

Lambou, V. W. 1959. Fish populations of backwater lakes in Louisiana. Trans. Amer. Fish. Soc., 88: 7-15.

Lantz, K. E. 1971. Chicot Lake (Evangeline Parish). Louisiana Wild Life and Fisheries Commission, Capitol Station, Baton Rouge, Louisiana 70804.

Liner, E. A. 1949. Studies on the fauna and flora of Cypress Lake. Proc. La. Acad. Sci. 12: 34-37.

Longest, W. D. 1966. The Fresh-Water Tricladida of the Florida Parishes of Louisiana. Ph.D. Dissertation. Louisiana State University, Baton Rouge.

Louisiana Wild Life and Fisheries Commission. 1964. Sport Fish Investigations, Projects: F7R, F8R and F9R, July 1, 1962 - June 30, 1963. New Orleans. 53p.

_______. 1969. Louisiana Sport Fish Investigations Federal Aid Projects Annual Report, July 1, 1968 - June 30, 1969. Baton Rouge. 202p.

Moore, W. G. 1950. Limnological studies of Louisiana lakes. I. Lake Providence. Ecology 31: 86-99.

______. 1952. Limnological studies of Louisiana lakes. II Lake Chicot. Proc. La. Acad. Sci. 15: 37-49.

______. 1963. Central Gulf States and the Mississippi Embayment, p. 287-300. In: D. G. Frey, ed.; Limnology in North America. The Univ. of Wisconsin Press, Madison.

______. 1970. Limnological studies of temporary ponds in southeastern Louisiana. Southwestern Naturalist 15(1): 83-110.

Mortimer, C. H. 1956. In: G. C. Sellery, ed.; E. A. Birge. Univ. of Wisconsin Press, Madison.

Neel, J. K., H. P. Nicholson and A. Hirch. 1963. Main stem reservoir effects on water quality in the central Missouri River, 1952-1957. U. S. Dept. of the Inter., Public Health Service, Reg. IV, Div. of Water Supply and Pollution Control, Kansas City, Missouri.

Moyle, J. B. 1945. Classification of lake waters upon the basis of hardness. Proc. Minn. Acad. Sci. 13: 8-12.

______. 1949. Some indicies of lake productivity. Trans. Amer. Fish. Soc. 76(1946): 322-334.

Odom, L. M. 1968. A Report on a Study of City Park Lake and Lake Erie with Recommendations for their Improvement. Unpublished Report Prepared for Parish of East Baton Rouge, Louisiana, Woodrow W. Dumas, Mayor-President.

Odum, E. P. 1969. Fundamentals of Ecology. W. B. Saunders Co., Philadelphia, Pa. 574p.

O'Hara, J. 1967. Invertebrates found in water hyacinth mats. Quart. J. Fla. Acad. Sci. 30(1): 73-80.

Palmer, C. M. 1962 Algae in Water Supplies. Public Health Service Publications #657. U. S. Government Printing Office, Washington 25, D. C. 88p.

Patrick, Ruth and C. W. Reimer. 1966. The Diatoms of the United States exclusive of Alaska and Hawaii. Vol. I. Fragilariaceae, Eunotiaceae, Achnanthaceae, Naviculaceae. Monographs of the Acad. Nat. Sci., Philadelphia, No. 13. Philadelphia, Pa.

Pearsall, W. H. 1930. Phytoplankton in the English Lakes. I. The Proportions in the Water of Some Dissolved Sbustances of Biological Importance. J. Ecol. 18: 306-320.

________. 1932. Phytoplankton in the English Lakes. II. The composition of the phytoplankton in relation to dissolved substances. J. Ecol. 20: 241-262.

Penfound, W. T. 1949. Vegetation of Lake Chicot, Louisiana in relation to wildlife resources. Proc. La. Acad. Sci. 12: 47-56.

Pennak, R. W. 1953. Fresh-Water Invertebrates of the United States. The Ronald Press Co., New York. 769p.

Pesnell, G. L. 1971. The Ecology of Toledo Bend Reservoir: physicochemical and primary productivity studies. M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 49p.

Poirrier, M. A. 1969. Louisiana Fresh-Water Sponges: Taxonomy, Ecology and Distribution. Ph.D. Dissertation. Louisiana State University, Baton Rouge. 105p.

________. 1973. Unpublished report to New Orleans' Audubon Park Commission on the control of Pithophora. Louisiana State University in New Orleans, New Orleans, Louisiana.

Prescott, G. W. 1939. Some Relationships of Phytoplankton to Limnology and Aquatic Biology. In: Problems of Lake Biology. Publ. Amer. Assn. Advan. Sci. # 10. 142p.

________. 1942. The fresh-water algae of southern United States. II. The algae of Louisiana with descriptions of some new forms and notes on distribution. Trans. Amer. Microsc. Soc. 61: 109-119.

________. 1951. Algae of the Western Great Lakes Area. Cranbrook Institute of Sci. Bull. 31. Broomfield Hills, Michigan. 946p.

________. 1964. How to Know the Fresh-Water Algae. Wm. C. Brown Co., Dubuque, Iowa. 272p.

________ and W. C. Vinyard. 1965. Ecology of Alaskan fresh-water algae V. Limnology and flora of Malikpuk, Lake. Trans. Amer. Microsc. Soc. 84(4): 427-478.

Radford, A. E., H. E. Ahles and R. C. Bell. 1968. Manual of the Vascular Flora of the Carolinas. Univ. North Carolina Press. Chapel Hill. 1183p.

Rawson, D. D. 1939. Some Physical and Chemical Factors in the Metabolism of Lakes. In: Problems of Lake Biology. Publ. Amer. Assn. Advan. Sci. # 10. 142p.

_______. 1944. The calculation of oxygen saturation values and their correction for altitude. Limnol. Soc. Amer. Spec. Publ. # 15.

Reames, E. E. 1907. A Classification and Description of the Fresh-Water Algae of Louisiana. M.A. Thesis, Tulane University, New Orleans, Louisiana.

Reid, G. K. 1961. Ecology of Inland Waters and Estuaries. Van Nostrand Reinhold Co., New York. 375p.

Reimers, N. 1958. Conditions of existance, growth and longevity of brook trout in a small, high-altitude lake of the eastern Sierra Nevada. Calif. Fish and Game 44: 319-333.

Respess, R. O., C. E. Wood, J. M. Inglis and W. J. Clark. 1972. Seasonal variations in physicochemical conditions of a small lake in Brassas County Texas. Southwestern Naturalist 17(3): 249-263.

Ruttner, Franz. 1953. Fundamentals of Limnology. Univ. of Toronto Press. Toronto, Ontario, Canada. 242p.

Sawyer, R. T. 1967. The leeches of Louisiana, with notes on some North American species (Hirudinea, Annelida). Proc. La. Acad. Sci. 30: 32-38.

_______. 1972. North American Freshwater Leeches, Exclusive of the Piscicolidae, with a Key to all Species. Ill. Biol. Mono. 45, Univ. Illinois Press, Urbana. 154p.

Sechriest, R. E. 1960. Relationship between total alkalinity, conductivity, original pH and buffer action of natural water. Ohio J. Sci. 60(5): 303-308.

Shannon, E. E. and P. L. Brezonik. 1972. Limnological characteristics of north and central Florida lakes. Limnol. and Ocean. 17(1): 97-110.

Smith, G. W. 1950. The Fresh-Water Algae of the United States. 2nd. ed. McGraw-Hill Book Co., New York. 719p.

Smith, R. F. 1959. General Limnology of Selected Water Bodies in the Western Part of Cameron Parish, Louisiana and Its Relationship to the Emergence of Tendipedidae. M.S. Thesis, Northwestern State University, Natchitoches. 115p.

Stern, D. H., B. H. Atwell, E. L. Merz and M. J. Vinet. 1968. A summer limnological study of Lake Pontchartrain, Louisiana. La. Water Resources Research Inst. Tech. Report No. 3. Baton Rouge. 83p.

Stern, D. H. and M. S. Stern. 1969. Physical, chemical, bacterial, and plankton dynamics of Lake Pontchartrain, Louisiana. La. Water Resources Research Inst. Tech. Report No. 4. Baton Rouge. 60p.

Stokes, Sammy. 1971. Black Lake (Natchitoches Parish). Louisiana Wild Life and Fisheries Commission, Capitol Station, Baton Rouge, Louisiana 70804.

Sublette, J. E. and M. S. Sublette. 1957. The Physicochemical features and bottom fauna of Chaplin's Lake, Natchitoches Parish, Louisiana, Proc. La. Acad. Sci. 20: 85-94.

Tafaro, J. T. 1967. A survey of the Tubificidae (Oligochaeta, Annalida) from Southern Louisiana, Proc. La. Acad. Sci. 30: 21-23.

Taft, C. E. 1946. Some Oedogoniaceae and Zygnemataceae from Texas and Louisiana. Trans. Amer. Microsc. Soc. 65: 18-26.

Times Picayune. July 9, 1961. The Lakes of the Capitol. New Orleans Times Picayune.

Thompson, E. T. 1933. Distribution of Grasses in East Baton Rouge Parish, M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana.

Tressler, W. T. 1939. The Zooplankton in Relation to the Metabolism of Lakes. In: Problems of Lake Biology. Publ. Amer. Assn. Advan. Sci. # 10. 142p.

Twilley, C. E. 1970. Effects of Kraft Paper Mill Effluent on Species Diversity of Benthic Macroinvertebrates in Dugdemona River before and after Initiation of a Lime Clarification Process. M.S. Thesis, Louisiana Tech. University, Ruston, Louisiana. 69p.

Usinger, R. L. (ed.). 1971. Aquatic Insects of California with Keys to North American Genera and California Species. Univ. Calif. Press, Berkely, Calif. 508p.

Velez, Ismael. 1934. Succession of Plants in a Cleared Swamp Area, M.S. Thesis, Louisiana State University, Baton Rouge, Louisiana. 61p.

Ward, H. B. and C. C. Whipple. 1959. Fresh-Water Biology. 2nd. John Wiley & Sons, Inc., New York. 1248p.

Warren, C. E. 1971. Biology and Water Pollution Control. W. B. Saunders Co., Philadelphia, Pennsylvania. 434p.

Welch, P. S. 1935. Limnology. McGraw-Hill Book Co., New York. 471p.

______. 1948. Limnological Methods. The Blakison Co., Philadelphia, Pennsylvania. 381p.

______. 1952. Limnology. McGraw-Hill Book Co., Inc., New York. 538p.

White, F. A. 1949. Preliminary notes on the breeding season of Palaemonetes kadiakensis Rathbun in the Baton Rouge area. Broc. La. Acad. Sci. 12: 71-75.

Whitford, L. H. and G. J. Schumacher. 1969. A Manual of the Fresh-Water Algae in North Carolina. The North Carolina Agr. Exp. Sta., Raleigh. 313p.

Williams, A. M. 1971. Lake LaFourche (Caldwell Parish). Louisiana Wild Life and Fisheries Commission, Capitol Station, Baton Rouge, Louisiana 70804.

Young, W. C., H. H. Hannan and J. W. Tatum. 1972. The physicochemical limnology of a stretch of the Guadalupe River, Texas, with five main-stream impoundments. Hydrobiologia 40(3): 297-319.

APPENDICES

Appendix A

Physicochemical Parameters of the Surface Waters of the University Lake System, July, 1973 - June, 1973

Legend. The following data are reported as ppm with these exceptions:

Color - Platinum - Cobalt Units (PCU).

Turbidity - Jackson Turbidity Units (JTU).

Temperatures - degrees Centigrade

Specific Conductance - micromhos/cm

Station 1

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	160	140	160	110	180	190	105	70	100
Turbidity	-	-	-	40	42	40	30	55	54	30	24	10
% Transmittance				91	85	94	89	83	90	90	100	94
THERMAL PROPERTIES												
Air Temperature	27	29	32	26	22	10	23	12	18	23	25	31
Water Temperature	28	30	32	25	20	10	12	13	20	24	25	33
DISSOLVED GASES												
Free Carbon Dioxide	1.1	1.5	0	0	1.7	3.0	6.6	0	3.9	3.2	0	0
Dissolved Oxygen	12.0	5.0	12.3	10.0	8.9	9.7	10.0	12.4	6.6	-	8.2	11.0
NH_3 - Nitrogen	-	-	-	0.4	1.1	1.9	0.4	0.6	0.6	0.4	0.4	0.6
Hydrogen Sulfide	-	-	-	0.04	0.10	0	0.04	0.10	0.10	0.10	0.02	0.10

Station 1

DISSOLVED SOLIDS	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Total Hardness	-	-	-	171	86	102	120	103	86	68	68	68
Calcium Hardness	-	-	-	51	51	51	34	34	34	34	34	34
Magnesium Hardness	-	-	-	120	34	51	86	69	52	34	34	34
Total Alkalinity	55	33	35	34	27	27	24	37	51	40	45	50
Phenolhthalein Alkalinity	0	0	10	1	0	0	0	5	0	0	5	18
Methyl Orange Alkalinity	55	33	25	33	27	27	24	32	51	40	40	32
Chloride	7.0	10.9	14.6	12.7	12.7	10.0	9.1	10.0	11.0	11.0	11.0	9.0
Iron	-	-	-	-	-	-	-	-	0.9	0.5	0.2	0.3
Copper	-	-	-	-	-	-	-	-	0.3	0.3	0.3	0.3
Ortho-Phosphate	2.40	-	1.10	0.20	0.03	2.00	0.10	0.20	0.30	0.10	0.10	0.10
Nitrate-Nitrogen	0.20	-	0.10	0.20	0.40	0.30	0.10	0	0.02	0	0	0
Specific Conductance	135	150	160	155	155	130	120	90	122	87	78	80
pH	8.5	8.0	9.6	8.4	7.9	7.1	7.2	8.7	7.4	8.3^{-}	8.9	9.6^{+}

Station 2

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	255	180	130	105	170	145	125	100	159
Turbidity	-	-	-	75	50	30	30	45	39	40	34	35
% Transmittance	-	-	-	82	87	94	90	83	95	86	96	81
THERMAL PROPERTIES												
Air Temperature	27	29	31	25	21	6	23	11	17	23	27	32
Water Temperature	28	29	32	26	21	8	13	10	19	23	25	33
DISSOLVED GASES												
Free Carbon Dioxide	0	0	0	0	0	0	4.3	0	0	4.0	0	0
Dissolved Oxygen	13.0	3.2	14.8	12.7	13.3	13.8	11.0	12.8	11.2	-	8.6	13.4
NH_3 - Nitrogen	-	-	-	0.6	0.9	1.5	1.0	0.4	0.5	0.4	0.4	0.7
Hydrogen Sulfide	-	-	-	0.10	0.04	0.10	0.10	0.10	0.10	0.10	0.04	0.10

Station 2

DISSOLVED SOLIDS	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Total Hardness	-	-	-	154	68	120	103	103	103	68	68	68
Calcium Hardness	-	-	-	68	51	34	34	34	51	34	34	34
Magnesium Hardness	-	-	-	86	17	86	69	69	52	34	34	34
Total Alkalinity	69	38	29	39	35	30	20	32	50	40	42	55
Phenolhthalein Alkalinity	4.5	5.0	3.5	24.0	8.0	7.0	0	9.0	9.0	0	3.0	29.0
Methyl Orange Alkalinity	64	33	25	15	27	23	20	23	41	40	39	26
Chloride	8.5	10.9	11.8	10.0	11.8	9.1	6.4	12.7	17.0	8.0	11.0	6.0
Iron	-	-	-	-	-	-	-	-	0.4	0.4	0.3	0.5
Copper	-	-	-	-	-	-	-	-	0.3	0.3	0.3	0.3
Ortho-Phosphate	4.00	-	1.70	0.10	0.04	0.70	0.10	0.10	0.40	0.03	0.20	0.20
Nitrate-Nitrogen	0.3	-	0.2	0.3	0.2	0.2	0.1	0	0	0	0	0
Specific Conductance	137	195	180	175	155	120	120	100	130	77	75	104
pH	8.6	8.8	9.6	8.6	9.2	8.4	7.2	8.8	9.4	8.3^-	8.6	9.6^+

Station 3

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	265	240	210	97	165	180	145	138	140
Turbidity	-	-	-	75	62	60	22	50	40	40	38	25
% Transmittance	-	-	-	83	85	85	93	82	95	87	92	86
THERMAL PROPERTIES												
Air Temperature	29	29	29	28	22	8	22	11	15	24	24	30
Water Temperature	-	30	30	26	20	7	14	9	18	-	24	30
DISSOLVED GASES												
Free Carbon Dioxide	2.3	1.5	1.2	7.0	0	4.3	4.0	0	1.1	-	0	0
Dissolved Oxygen	11.0	4.6	5.0	5.1	8.9	11.5	11.3	12.4	8.7	-	10.0	4.8
NH_3 - Nitrogen	-	-	-	0.7	0.8	0.7	0.6	0.5	0.7	0.5	0.5	0.8
Hydrogen Sulfide	-	-	-	0.03	0.10	0.10	0.10	0.10	0	0	0.02	0.10

Station 3

DISSOLVED SOLIDS	Jan.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.
Total Hardness	-	-	-	137	68	120	120	103	86	86	68	68
Calcium Hardness	-	-	-	51	34	34	34	34	51	34	34	34
Magnesium Hardness	-	-	-	86	34	86	86	69	35	52	34	34
Total Alkalinity	56	36	33	33	30	25	20	37	53	-	40	38
Phenolhthalein Alkalinity	0	0	0	0	2	0	0	4	0	-	12	8
Methyl Orange Alkalinity	56	36	33	33	28	25	20	33	53	-	28	30
Chloride	7.5	11.8	10.0	13.7	12.7	8.2	8.2	10.0	11.0	9.0	11.0	6.0
Iron	-	-	-	-	-	-	-	-	0.8	0.5	0.3	0.5
Copper	-	-	-	-	-	-	-	-	0.3	0.3	0.3	0.3
Ortho-Phosphate	2.50	-	0.10	0.10	0.10	0.50	0.10	0.10	0.40	0.02	0.14	0.20
Nitrate-Nitrogen	0.2	-	0.1	0.3	0.1	0.2	0	0	0	0	0	0
Specific Conductance	128	170	155	160	135	120	115	92	130	80	84	70
pH	7.8	8.2	8.4	7.7	8.7	7.3	8.6	8.6	7.4	8.3^-	9.6^+	9.6

Station 4

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	250	240	210	100	170	210	125	123	169
Turbidity	-	-	-	70	62	65	27	50	58	30	29	35
% Transmittance	-	-	-	80	83	82	93	82	90	93	94	79
THERMAL PROPERTIES												
Air Temperature	29	29	30	28	19	8	18	9	13	24	24	29
Water Temperature	-	28	29	26	19	6	13	8	12	-	24	32
DISSOLVED GASES												
Free Carbon Dioxide	0	1.5	0	0	0	3.0	2.5	0	2.1	2.8	0	0
Dissolved Oxygen	13.0	5.2	11.2	13.1	9.5	12.1	11.2	12.2	10.0	-	10.9	9.2
NH_3 -Nitrogen	-	-	-	0.7	0.9	0.7	0.4	0.6	0.8	0.5	0.3	0.7
Hydrogen Sulfide	-	-	-	0.10	0.10	0.10	0	0.10	0	0.10	0.01	0.10

Station 4

DISSOLVED SOLIDS	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.
Total Hardness	-	-	-	171	86	103	120	120	86	86	68	68
Calcium Hardness	-	-	-	51	34	34	34	51	51	34	34	34
Magnesium Hardness	-	-	-	120	51	69	86	69	35	52	34	34
Total Alkalinity	61	36	32	32	28	31	18	35	50	43	38	48
Phenolhthalein Alkalinity	7	0	12	10	3	0	0	1	0	0	12	15
Methyl Orange Alkalinity	54	36	20	22	25	31	18	34	50	43	26	33
Chloride	8.5	10.0	11.8	10.9	11.8	10.0	8.2	10.0	14.0	8.0	11.0	6.0
Iron	-	-	-	-	-	-	-	-	0.8	0.5	0.3	0.6
Copper	-	-	-	-	-	-	-	-	0.3	0.3	0.3	0.4
Ortho-Phosphate	2.5	-	1.2	0.1	0.1	0.2	0.3	0.1	0.2	0.1	0.1	0.2
Nitrate-Nitrogen	0.30	-	0.20	0.30	0.20	0.20	0.03	0	0	0	0	0
Specific Conductance	122	165	160	170	130	115	110	90	121	80	84	70
pH	8.7	8.6	9.6	8.8	9.0	7.1	7.2	8.4	7.5	8.3^-	9.6^+	9.6

Station 5

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	120	105	80	15	150	225	75	92	195
Turbidity	-	-	-	25	25	10	0	43	59	25	19	35
% Transmittance	-	-	-	95	90	100	100	85	88	90	98	85
THERMAL PROPERTIES												
Air Temperature	29	29	25	24	21	2	17	11	13	24	25	29
Water Temperature	-	30	28	23	19	6	13	13	18	-	26	32
DISSOLVED GASES												
Free Carbon Dioxide	0	0	0	0	0	5.0	7.0	2.7	0	3.6	0	0
Dissolved Oxygen	12.0	7.4	10.5	11.8	-	10.5	11.1	11.0	5.3	-	8.0	5.8
NH_3 - Nitrogen	-	-	-	1.0	0.3	0.3	0	0.5	0.5	0.3	0.3	0.8
Hydrogen Sulfide	-	-	-	0.10	0.10	0.02	0.10	0.10	0.04	0.02	0.03	0.14

Station 5

DISSOLVED SOLIDS	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Total Hardness	-	-	-	86	68	103	103	86	68	68	51	68
Calcium Hardness	-	-	-	17	51	34	17	17	34	17	34	17
Magnesium Hardness	-	-	-	69	17	69	86	69	34	51	17	51
Total Alkalinity	304	105	93	78	70	48	58	112	122	98	95	123
Phenolhthalein Alkalinity	17	8	72	25	13	0	0	0	4	0	2	5
Methyl Orange Alkalinity	287	97	21	53	57	48	58	112	118	98	93	118
Chloride	5.5	15.5	10.9	12.7	12.7	8.2	11.8	11.8	13.0	11.0	17.0	1.0
Iron	-	-	-	-	-	-	-	-	0.6	0.3	0.2	0.8
Copper	-	-	-	-	-	-	-	-	0.3	0.3	0.3	0.4
Ortho-Phosphate	2.8	-	0.1	0.5	0.5	0.3	0.5	0.4	0.6	0.3	0.2	1.0
Nitrate-Nitrogen	0.90	-	0.10	0.20	0.02	0.10	0.03	0.04	0	0	0	0
Specific Conductance	370	450	330	280	260	180	240	200	220	157	200	195
pH	8.9	9.0	9.6^+	9.6	9.2	7.6	7.7	8.0	8.4	8.3^-	8.4	8.4

Station 6

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	450	400	275	175	310	185	215	310	229
Turbidity	-	-	-	140	115	75	45	81	49	51	88	58
% Transmittance	-	-	-	71	73	83	84	75	90	87	80	74
THERMAL PROPERTIES												
Air Temperature	-	-	26	27	20	6	18	9	14	24	25	29
Water Temperature	-	-	29	26	20	8	13	10	18	-	24	31
DISSOLVED GASES												
Free Carbon Dioxide	-	-	0	0	0	1.8	0	0	3.4	0	0	0
Dissolved Oxygen	-	-	-	15.7	10.1	11.2	15.5	14.5	6.6	-	13.2	10.9
NH_3 - Nitrogen	-	-	-	0.40	0.80	0.80	0.90	0.90	0.60	0.70	1.03	0.60
Hydrogen Sulfide	-	-	-	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Station 6

DISSOLVED SOLIDS	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Total Hardness	-	-	-	137	51	103	103	120	68	68	68	86
Calcium Hardness	-	-	-	34	34	34	34	34	34	34	34	17
Magnesium Hardness	-	-	-	103	17	69	69	86	34	34	34	69
Total Alkalinity	-	-	22	27	25	28	12	33	51	33	38	35
Phenolhthalein Alkalinity	-	-	17	12	5	0	2	13	0	15	17	13
Methyl Orange Alkalinity	-	-	5	15	20	28	10	20	51	18	21	22
Chloride	-	-	9.1	9.1	9.1	9.1	7.3	10.9	13.0	8.0	11.0	6.0
Iron	-	-	-	-	-	-	-	-	1.1	1.0	1.3	0.7
Copper	-	-	-	-	-	-	-	-	0.3	0.5	0.7	0.5
Ortho-Phosphate	-	-	-	0.6	0.6	0.7	0.5	0.1	1.2	1.0	1.5	1.1
Nitrate-Nitrogen	-	-	-	0.10	0	0	0.04	0	0	0	0	0
Specific Conductance	-	-	-	180	110	90	90	70	118	47	56	68
pH	-	-	8.7	9.0	9.2	7.1	9.3	9.6	7.2	8.3^{+}	9.6^{+}	9.6^{+}

Station 7

OPTICAL PROPERTIES	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Color	-	-	-	-	-	140	120	162	125	90	85	90
Turbidity	-	-	-	-	-	30	30	53	31	21	10	10
% Transmittance	-	-	-	-	-	93	89	83	90	92	90	92
THERMAL PROPERTIES												
Air Temperature	-	-	-	-	-	8	23	12	18	24	24	31
Water Temperature	-	-	-	-	-	9	13	10	20	24	26	33
DISSOLVED GASES												
Free Carbon Dioxide	-	-	-	-	-	3.1	2.4	2.2	2.7	5.0	4.0	4.5
Dissolved Oxygen	-	-	-	-	-	10.1	13.5	11.4	6.0	-	7.4	5.0
NH_3 - Nitrogen	-	-	-	-	-	0.5	0.5	0.6	0.3	0.4	0.4	0.6
Hydrogen Sulfide	-	-	-	-	-	0.03	0.10	0.10	0.10	0.03	0	0.10

Station 7

DISSOLVED SOLIDS	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Total Hardness	-	-	-	-	-	103	103	103	51	86	51	86
Calcium Hardness	-	-	-	-	-	51	34	34	51	34	34	34
Magnesium Hardness	-	-	-	-	-	51	69	69	0	52	17	52
Total Alkalinity	-	-	-	-	-	25	26	38	36	40	38	53
Phenolhthalein Alkalinity	-	-	-	-	-	0	0	0	0	0	0	0
Methyl Orange Alkalinity	-	-	-	-	-	25	27	38	36	40	38	53
Chloride	-	-	-	-	-	7.3	7.3	31.9	25.0	8.0	11.0	7.0
Iron	-	-	-	-	-	-	-	-	0.4	0.4	0.3	0.4
Copper	-	-	-	-	-	-	-	-	0.2	0.2	0.3	0.2
Ortho-Phosphate	-	-	-	-	-	0.1	0.1	0.4	0.4	0.2	0.1	0.4
Nitrate-Nitrogen	-	-	-	-	-	0.3	0.1	0	0	0	0	0
Specific Conductance	-	-	-	-	-	115	120	130	165	70	75	96
pH	-	-	-	-	-	7.1	7.7	7.9	7.3	8.3	7.6	7.3

Appendix B

Ranges for Extractable Nutrients (ppm), Soil Reaction (pH), Per Cent Organic Matter and Soil Types of the University Lake System Bottom Sediments

	Extractable Nutrients					Soil Reaction
	P	K	Ca	Mg	Na	(pH)
Station						
1	93-139	30-155	2120-4000	182-621	-	6.8-7.0
2	214-330	78- 90	1960	132	136	6.2-6.3
3	229-241	35- 60	1840-3720	109-267	-	5.8-6.6
4	119-166	80-105	1520-1760	217-283	152	5.8-6.0
5	100-118	35- 45	2000-4000	173-184	160-164	6.1-7.3
6	239-278	145-220	2360-2800	119-274	109-140	6.5-7.0
7	103-241	40-105	2000-3240	181-259	120	6.7-7.1

Station	% Organic Matter	Soil Type
1	1.35-3.35	Sandy
2	1.98-3.70	Very Fine Sandy Loam
3	1.27-3.07	Silty Clay Loam - Fine Sandy Loam
4	2.21-3.12	Silt Loam - Fine Sandy Loam
5	1.56-3.28	Sandy Loam - Sandy
6	1.61-1.85	Fine Sandy Loam - Silt Loam
7	1.25-3.28	Silty Clay Loam - Silt Loam

Appendix C

Flora of the University Lake System

The algae and higher vascular plants are listed phylogenetically by phylum and alphabetically therein. Included is the author's collection number (vascular plants only), distribution and an estimate of relative abundance (A - abundant; F - frequent; I - infrequent; P - present, no estimate of abundance). Unless otherwise stated, all collections and identifications were made by the author.

Algae	Interconnected Lakes (Station 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
CYANOPHYTA			
Agmenellum quadriduplicatum Brebisson	F		
Anabaena spiroides Klebahn	A	A	A
Anabaenopsis circularis (W. & G.S. West) Miller	F	F	F
Anacystis cyanea Drouet & Dailey	I	F	
Arthrospira jenneri (Kurtz.) Stiz.	I		

Algae	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Dactylococcopsis acicularia Lemm.	I-F		
Oscillatoria chlorina Kuetz Id. Lewis Flint (Prescott, 1942)	P		
O. limosa (Roth) C. A. Agardh.		A	
O. tenuis Agardh.	F		
O. tenuis Agardh. Id. Lewis Flint (Prescott, 1942)	P		
Unidentified, *Romeria*-like	F		
CHRYSOPHYTA			
Chrysosphaerella longispina Lauterb.	F		
Diatoms (epiphytic)	F	F	F
Fragularia sp.	P		
Frustulia rhomboides (Ehr.) De Toni.		I	
Navicula sp.	I	I	
Tribonema bombycinum (Ag.) Derbes & Sol.	I		
CHLOROPHYTA			
Actinastrum gracillimum G. M. Smith	I		
Ankistrodesmus falcatus (Corda) Ralfs.	A		

Algae	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Chlamydomonas sp.	I		
Chlorella sp.	F		
Cladophora sp. (not fruiting)	I		
Closterium moniliforme (Bory.) Ehr.	I		
Cosmarium sp.	I		I
Gonium pectorale Muell.	I	A	
Hydrodictyon sp. Odom, 1968	P		
Microspora amoena (Kutz.) Rab.	I		
Oedogonium sp. (not fruiting)	I		I
Pandorina morum Bory.	F	F	
Pediastrum simplex (Meyen) Lemm.	I		
Pediastrum sp./spp.	I		
Pithophora sp. Odom, 1968	A		
P. oedogonia (Mont.) Wittr. Prescott, 1942	A		
Rhizoclonium sp. Odom, 1968	P		
Scenedesmus acuminatus (Lag.) Chod.	I	P	

Algae	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
S. abundans (Kirchner) Chod.	P	P	
S. dimorphus (Turp.) Kuetz.	P	P	
S. quadricauda (Turp.) de Breb.	A	I	
Spirogyra sp./spp. (not fruiting)	I		
Staurastrum sp.	I		
EUGLENOPHYTA			
Euglena (probably *spirogyra* Ehr.)		F	
E. (probably *oxyuris* Schmarda)	I		

Vascular Plants	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
SPERMATOPHYTA			
Amaranthaceae			
Alternanthera philoxeroides (Marius) Griseb. shoreline, 728	F	F	I
Apiaceae			
Hydrocotyle umbellata L. shoreline, 657	I		
Lilaeopsis carolinensis C. & R. shoreline, 1438	I		
Araceae			
Colocasia antiquorum (L.) Schott shoreline, 1495	A		
Asteraceae			
Ambrosia artemisiifolia L. shoreline, 1444	I		
Ambrosia trifida L. shoreline, 1445	I		
Eclipta alba (L.) Hassk. shoreline, 727	I	I	

Vascular Plants	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Brassicaceae			
Lepidium virginicum L. shoreline, 614	I		
Convolvulaceae			
Dichondra repens Forster-G. shoreline, 619	I		
Commelinaceae			
Commelina caroliniana Walter. shoreline, 607	I		
Tradescantia ohiensis Raf. shoreline, 667	I		
Cyperaceae			
Carex frankii Kunth. shoreline, 645	I		
Cyperus odoratus L. shoreline, 658	F		
Fabaceae			
Sesbania exaltata (Raf.) Cory shoreline, 662	I		

Vascular Plants	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Juncaceae			
<u>Fimbristylis autumnalis</u> (L.) Ros. shoreline, <u>672</u>	I		
<u>Juncus biflorus</u> Ell. shoreline, <u>621</u>	I		
Lemnaceae			
Duckweed Odom, 1968	P		
<u>Lemna minor</u> L. floating, <u>724</u>	I	I	
<u>Spirodela polyrhiza</u> (L.) Schleid. floating, <u>725</u>	I	I	
Malvaceae			
<u>Sida rhombifolia</u> L. shoreline, <u>630</u>	I		
Najadaceae			
<u>Najas</u> sp. Odom, 1968	P		
Onagraceae			
<u>Ludwigia bonariensis</u> (Micheli) Hara shoreline, <u>1439</u>	I		

Vascular Plants	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
L. peploides shoreline, 1494	I		
Poaceae			
Digitaria adscendens (H.B.K.) Hener. shoreline, 669	I		
Echinocloa walteri (Pursh.) Heller. shoreline, 674	I		
E. colonum (L.) Link. shoreline, 673	I		
Panicum sp. Odom, 1968	P		
Paspalum dilatatum Poir. shoreline, 654	F		
P. urvillei Steud. shoreline, 620	F		
Sorghum halepense (L.) Pers. shoreline, 671	I		
Sporobolus poiretii (R. & S.) Hitchc. shoreline, 656	F		
Zizaniopsis miliaceae (Michx.) Doll & Aschers. shoreline, 651	I		

Vascular Plants	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Polygonaceae			
Polygonum pensylvanicum L. shoreline, 1442	I		
P. punctatum Ell. shoreline, 1443	I		
Pontederiaceae			
Eichhornia crassipes (Marius) Solms. shoreline & floating, 601	F		
Rubiaceae			
Cephalanthus occidentalis L. shoreline, 641	I		
Diodia virginiana L. shoreline, 610	I		
Saururaceae			
Saururus cernuus L. shoreline, 627	I		
Taxodiaceae			
Taxodium distichum (L.) Richard basin, 622	I		

Vascular Plants	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Urticaceae			
Boehmeria cylindrica (L.) Swartz. shoreline, 726	I	I	
Verbenaceae			
Verbena brasiliensis Vellozo. shoreline, 615	I		
Zosteraceae			
Potamogeton sp. Odom, 1968	P		

Appendix D

Fauna of the University Lake System

The invertebrates and fishes are listed phylogenetically by phylum and alphabetically therein. Included is the distribution and an estimate of relative abundance (A - abundant, F - frequent, I - infrequent, P - present, no estimate of abundance). Unless otherwise stated, all collections and identifications were made by the author.

Invertebrates	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
PROTOZOA			
Ciliata			
<u>Campanella</u> sp.	A		
<u>Epistylis</u> sp.	A		
<u>Vorticella</u> sp.	A		
<u>Zoothamnium</u> sp.	A	A	
Suctorea			
<u>Acineta</u> sp.	A		

Invertebrates	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
COELENTERATA			
Hydrozoa			
Hydra americana Hyman	A	A	
PLATYHELMINTHES			
Turbellaria			
Rhabdocoela	A	A	A
Macrostomum sp.		A	
Tricladida			
Dugesia tigrina (Girard)	A	A	
NEMERTEA			
Prostoma rubrum (Leidy) Harman, 1962	P		
Rotifera			
Monogononta	A	A	A
Flosculariacea	A		
Sinantherina sp.	F		
Ploima			
Brachionus spp.	A	A	A

Invertebrates	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
NEMATODA			
Aphasmidia			
Actinolaimus sp.	P		
Phasmidia			
Diplogaster sp.	A	P	P
ECTOPROCTA			
Hyalinella punctata (Hancock)		P	
Plumatella repens L.	A	A	A
ANNELIDA			
Hirudinea			
Erpobdellidae			
Dina parva	P		
Erpobdella punctata (Leidy) Sawyer, 1967	P		
Mooreobdella microstoma (Moore)	P		
Glossiphoniidae			
Helobdella elongata (Castle)	P		P

Invertebrates	Interconnected Lakes (Station 1-4, 7)	Campus Lake (Station 5)	College Lake Station 6)
H. fusca (Castle)	I		
H. lineata (Verrill)	F	I	
H. stagnalis (L.)	A		
Placobdella multilineata Moore Sawyer, 1967	P		
P. parasitica (Say) Sawyer, 1967	P		
Oligochaeta			
Aeolosomatidae			
Aeolosoma sp.	A		
Naididae			
Aulophorus sp.	A		
A. furcatus (Muller)		P	
Dero sp.	A		
Paranais sp.	P		
Pristina aequiseta Bourne	P		
P. longidentata Harman Harman, 1965	P		
P. longiseta Ehr.	P		

Invertebrates	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Lumbriculidae			
Lumbriculus inconstans Smith	P		
Tubificidae		P	
Limnodrilus sp.	P		
L. hoffmeisterii Claparede Tafaro, 1967	P		
ARTHROPODA			
Crustacea			
Amphipoda			
Gammarus sp.	I		
Hyalella azteca (Saussure)	A	A	
Cladocera	F	F	F
Chydorinae	F		
Pseudosida bidentata Herrick	P		
Copepoda			
Nauplius larvae	F	F	A
Cyclopoida	F	F	A
Eucyclops agilis (Koch)	F		
Decapoda			
Palaemonetes kadiakensis Rathbun	F	F	

Invertebrates	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Isopoda			
Asellus militaris Hay	F		
Ostracoda			
Cypridae	F		
Candona stagnalis Sars	P		
Insecta			
Coleoptera			
Dytiscidae			
Dytiscus sp.	P		
Hydrocanthus sp.		P	
Gyrinidae			
Dineutus sp.	F	F	F
Halipidae			
Peltodytes sp.		I	
Helodidae	F		
Hydrophilidae	F		
Helophorus sp.	P		
Diptera			
Tendipedidae pupa	I	I	I

Invertebrates	Interconnected Lakes (Stations 1-4, 7)	Campus Lake (Station 5)	College Lake (Station 6)
Tendipedidae larvae	A	A	A
Prodiamesa sp.		P	
Tendipes sp.	F	F	F
Ephemeroptera			
Caenis sp.		P	
Siphloplecton sp.		P	
Hemiptera			
Belostomatidae			
Belostoma flumineum Say	I		
Benacus griseus (Say)		P	
Hebridae			
Merragata sp.	I		
Notonectidae			
Notonecta sp.		F	
Odonata			
Anisoptera			
Brechmorrhoga mendax (Hagen)		P	
Dythemis sp.		P	
Erythrodiplax sp.	P		
Nannothemis bella (Uhl.)	P		
Pachydiplax longipennis (Burm.)	F		